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ELECTRICAL SYSTEM COMPLIANCE GUIDELINE.(U)
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WASHINGTON, D.C. 20590

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16. Abstract

Electrical systens for many types of boats are complex. The regulations have selected critical areas pertaining to electrical systems from the standpoint of safety and stipulate requirements to assure good practice in these areas. Some requirements may be specifically applied, but many requirements interact with others such as determination of wire size and overcurrent protection. The large number of requirements and the possible interpretations tend to be confusing for those using these regulations.

Regulations are typically written in concise terms, the words and arrangement chosen to be enforceable and in some cases to be legally interpreted. This format prohibits explanations, recommendations, and easily detectable alternate solutions to be included. A regulation provides an outline about which a great deal of further information, interpretation, explanation, clarification and some helpful hints are needed in order to provide a good understanding and complianc with its intent.

This Electrical System Guideline attempts to fulfill the needs of the average boatbuilder in order to assist in achieving compliance with these regulations. It explains, interprets, clarifies, discusses, alternates, diagrams, tabulates, makes some recommendations and in general complements the regulation to improve the boatbuilder's understanding.

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4 JAN 1978

FOREWORD

THIS ELECTRICAL SYSTEMS COMPLIANCE GUIDELINE WAS PREPARED BY THE AMERICAN BOAT AND YACHT COUNCIL (ABYC), A NON-PROFIT PUBLIC SERVICE ORGANIZATION, UNDER A U. S. COAST GUARD CONTRACT AWARDED TO ABYC PURSUANT TO THE AUTHORITY CONTAINED IN SECTION 25 OF THE FEDERAL BOAT SAFETY ACT OF 1971 (P. L. 92-75).

THIS GUIDELINE DOES NOT DICTATE THE METHODS A MANUFACTURER MUST FOLLOW TO COMPLY WITH THE REGULATIONS, BUT IT IS INTENDED TO BE USED AS A GUIDE TO METHODS WHICH, IF THEY ARE FOLLOWED, WILL BE ACCEPTABLE TO THE COAST GUARD AS MEETING THE INTENT AND PURPOSE OF THE REGULATIONS.

THE MEMBERS OF ABYC HAVE MADE EVERY EFFORT TO MAKE THIS GUIDELINE ACCURATE AND CONSISTENT WITH THE ELECTRICAL SYSTEMS REGULATIONS, AND THE COAST GUARD HAS REVIEWED IT FOR ANY INCONSISTENCIES. IN CASES WHERE IT APPEARS A CONFLICT MAY EXIST, HOWEVER, USERS OF THIS GUIDELINE SHOULD ADHERE TO THE REQUIREMENTS OF THE REGULATIONS AND NOT THE SUGGESTED METHODS FOR COMPLIANCE DESCRIBED IN THIS GUIDELINE. ANY QUESTIONS SHOULD BE DIRECTED TO YOUR COAST GUARD DISTRICT BOATING STANDARDS OFFICE.

THE COAST GUARD WISHES TO THANK THE MEMBERS OF ABYC WHO CONTRIBUTED THEIR PERSONAL TIME TO THE DEVELOPMENT OF THIS COMPLIANCE GUIDELINE. THE GUIDELINE WILL AID SMALL VOLUME BOATBUILDERS WHO LACK LARGE ENGINEERING STAFFS AND EXTENSIVE TECHNICAL CAPABILITIES IN COMPLYING WITH THE REGULATIONS. THE RECREATIONAL BOATING PUBLIC WILL SOON REALIZE THE BENEFITS OF THE ELECTRICAL SYSTEMS REGULATIONS THROUGH A REDUCTION IN THE INCIDENCE OF FIRES AND EXPLOSIONS ABOARD RECREATIONAL BOATS.

D. F. LAUTH
Rear Admiral, U. S. Coast Guard
Chief, Office of Boating Safety

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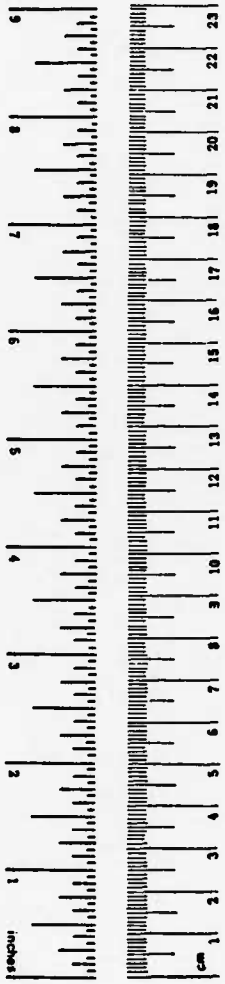
B: c(5); n(50)
C: None
D: None
E: s(2)
F: None

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

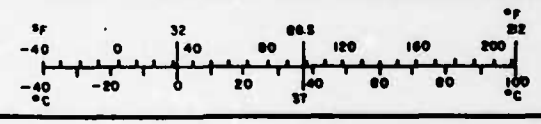
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	millilitsrs	ml
Tbsp	tablespoons	15	millsliters	ml
fl oz	fluid ounces	30	millilitsrs	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ELECTRICAL SYSTEM COMPLIANCE GUIDELINE

INTRODUCTION

Electrical systems for many types of boats are complex. The regulations have selected critical areas pertaining to electrical systems from the standpoint of safety and stipulate requirements to assure good practice in these areas. Some requirements may be specifically applied but many requirements interact with others such as determination of wire size and overcurrent protection. The large number of requirements and the possible interpretations tend to be confusing for those using these regulations.

Regulations are typically written in concise terms, the words and arrangement chosen to be enforceable and in some cases to be legally interpreted. This format prohibits explanations, recommendations, and easily detected alternate solutions to be included. A regulation provides an outline about which a great deal of further information, interpretation, explanation, clarification and some helpful hints are needed in order to provide a good understanding and compliance with its intent.

This electrical system guideline attempts to fulfill the needs of the average boatbuilder in order to assist in achieving compliance with these regulations. It explains, interprets, clarifies, discusses alternates, diagrams, tabulates, makes some recommendations and in general complements the regulation to improve the boat builder's understanding.

CAUTION

This guideline only addresses provisions of the Federal Regulations. It is not a complete engineering manual for the design of electrical systems on boats. There are other manuals and standards available for this purpose.

SUMMARY

The format of this guideline has been chosen to follow the sequence in the electrical system regulation. Obviously other arrangements could have been chosen however this format provides the many, many boatbuilders and component suppliers, who have followed the development of the regulation, a familiar sequence of information, thereby reducing confusion.

Each portion of the regulation has been stated in a box identified by **ITS THE LAW**. The effective date of this portion of the regulation is stated and then a discussion follows. The discussion; explains, interprets, clarifies, identifies interdependence of requirements and is designed to improve the understanding of the intent of the regulatory requirement. Diagrams are freely used and tables included wherever they can be helpful.

The discussion, diagrams and tables are followed by a box identified by **DO YOU COMPLY**, which asks questions to which the answer must be **YES** if compliance is achieved. This is a checklist for each regulatory requirement.

There is an appendix that contains some diagrams of typical electrical systems installations on various types of boats. These diagrams are annotated to show the applicable section of the regulation. The systems shown are examples and are not intended to be limiting in any way. Both simpler and more complex systems may be installed on any of the depicted boats.

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GENERAL

PURPOSE, APPLICABILITY, AND EFFECTIVE DATES

DEFINITIONS

GENERAL

IT'S THE LAW

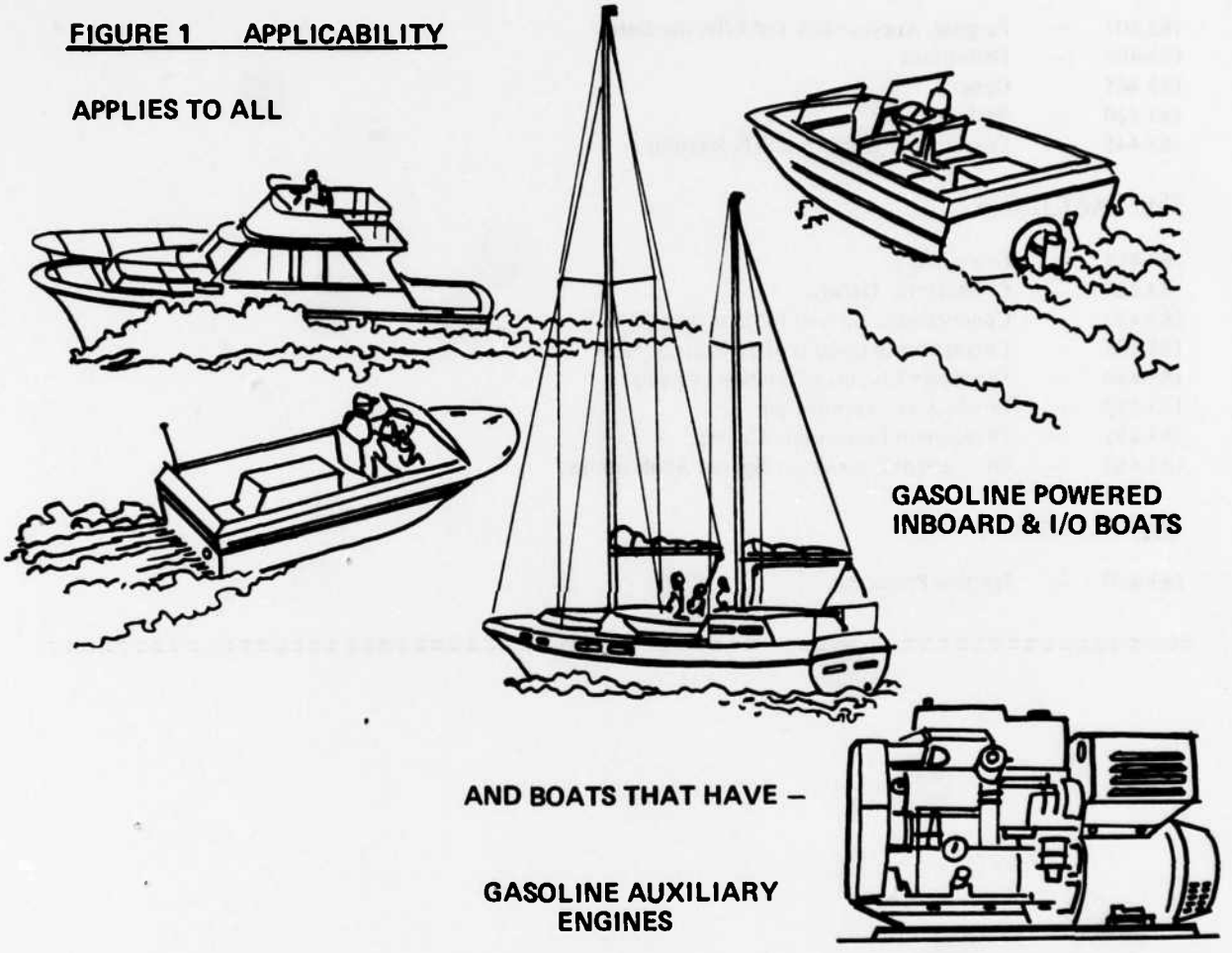
183.401 Purpose, applicability, and effective dates.

(a) This subpart applies to all boats that have gasoline engines for electrical or mechanical power or propulsion, except outboard engines.

EFFECTIVE DATE: AUGUST 1, 1977

FIGURE 1 APPLICABILITY

APPLIES TO ALL



NOTE: Boats powered with an outboard engine(s) are not subject to these regulations unless there is also a gasoline powered engine installed on the boat such as a gasoline powered auxiliary generator. The outboard motor and its associated control wiring are excepted. Associated control wiring includes power cables, ignition wires, gauge wires, etc. Electric trolling motors used on inboard or I/O boats are likewise excepted including their associated control wiring. A battery used only for the trolling motor becomes part of its associated control wiring and is therefore not subject to the regulation's requirements. This exception includes the securing and restraint requirements of 183.420.

IT'S THE LAW

183.401 Purpose, applicability, and effective dates.

(b) The sections in this subpart are effective on the following dates:

EFFECTIVE DATE: AUGUST 1, 1977

AUGUST 1, 1977

183.401 – Purpose, Applicability and Effective Dates
183.402 – Definitions
183.405 – General
183.420 – Batteries
183.445 – Conductors: Support and Protection

FEBRUARY 1, 1978

183.415 – Grounding
183.425 – Conductors: General
183.430 – Conductors in Circuits of Less than 50 Volts
183.435 – Conductors in Circuits of 50 Volts or More
183.440 – Secondary Circuits of Ignition Systems
183.450 – Conductors: Termination
183.455 – Overcurrent Protection: General
183.460 – Overcurrent Protection: Special Applications

AUGUST 1, 1978

183.410 – Ignition Protection

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(a) "ASTM" means American Society for Testing and Materials. ASTM standards in this subpart may be examined at Coast Guard Headquarters, Room 4314, Trans Point Building, 2100–2nd Street SW, Washington, DC 20590 and may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

EFFECTIVE DATE: AUGUST 1, 1977

There are no ASTM standards referenced in the regulation at this time. This information is provided in the event a future amendment may make such a reference.

There is, however, a reference made within a referenced SAE standard to:

ASTM D573 "Test for Rubber Deterioration in an Air Oven", reapproved in 1972. Applies to 183.430.

IT'S THE LAW

183.402 DEFINITIONS

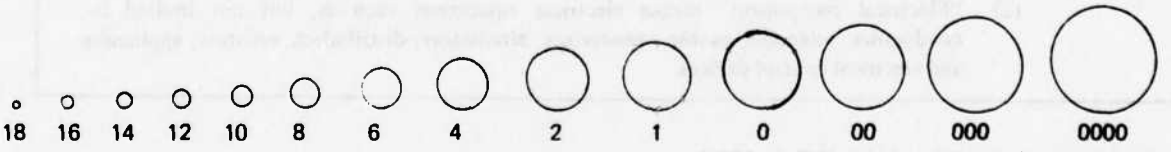
As used in this subpart –

(b) "AWG" means American Wire Gauge.

EFFECTIVE DATE: AUGUST 1, 1977

The gauge of a wire is its size. The American Wire Gauge is a nationally accepted convention for designating wire sizes. The higher the number, the smaller the diameter of the wire. For large sizes of wire 0, 00, 000 and 0000 are used with the more zeroes the larger the wire.

FIGURE 2 -- CONDUCTOR GAUGE (Insulation not included)



(APPROXIMATE SIZES – FOR COMPARISON ONLY)

TABLE I

CONDUCTORS

AWG OR SAE	MINIMUM ACCEPTABLE CM AREA	APPROXIMATE DIAMETER OF WIRE–INCHES (Insulation not included)
18	1537	.050
16	2336	.060
14	3702	.075
12	5833	.090
10	9343	.115
8	14810	.160
6	25910	.210
4	37360	.275
2	62450	.335
1	77790	.375
0	98980	.420
00	125100	.475
000	158600	.535
0000	205500	.595

Conductors may be labeled with their size. If not, and the size is to be determined, then measure the diameter of an individual strand using a micrometer. Square the diameter of the strand (in mils) and multiply by the number of strands in the conductor. This will provide to total circular-mil area of the conductor. Refer to Table I to find the gauge.

Formula: $CM = d^2 \times N$

d = diameter of one strand in mils (.001 inch)
N = number of strands in the conductor

NOTE: If a conductor contains strands of various sizes, measure the diameter of each strand, square the diameter, and add the individual circular-mil areas to obtain the total circular-mil area for the conductor.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(c) "Electrical component" means electrical equipment such as, but not limited to, conductors, solenoids, motors, generators, alternators, distributors, resistors, appliances and electrical control devices.

EFFECTIVE DATE: AUGUST 1, 1977

In general, any item related to the electrical system is an electrical component. A panel box is NOT itself an electrical component, but it contains a number of electrical components. Support clamps and straps and their fastenings are NOT electrical components.

It must be noted that the regulation's requirements apply to the installation of electrical components, and their external connection into the electrical circuit. The regulation does not apply to internal wiring or terminations within a component. For example, the windings of a motor, generator or alternator are not regulated, however the external wiring used to connect them to a boats's electrical system are required to comply with the regulation. The construction details of electrical components are only regulated is so far as whether the electrical component is or is not ignition protected.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(d) "IEEE" means Institute of Electrical and Electronic Engineers, Inc. IEEE standards in this subpart may be examined at Coast Guard Headquarters, Room 4314, Trans Point Building, 2100–2nd Street SW, Washington, DC 20590 and may be obtained from the Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, NY 10017.

EFFECTIVE DATE: AUGUST 1, 1977

The following IEEE standard is referenced in this Regulation

IEEE No. 45 "Recommended Practice for Electric Installations on Shipboard", effective December 3, 1970. Applies to 183.435.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(e) "NFPA" means National Fire Protection Association, NFPA standards in this subpart may be examined at Coast Guard Headquarters, Room 4314, Trans Point Building, 2100–2nd Street SW, Washington, DC 20590 and may be obtained from the National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02110.

EFFECTIVE DATE: AUGUST 1, 1977

The following NFPA standard is referenced in this Regulation.

NFPA No. 70-1975 (also ANSI C1-1975) "National Electrical Code", 1975 edition. Applies to 183.435.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(f) "Pigtails" means external power conductors or wires that are part of electrical components and appliances, such as bilge pumps, blowers, lamps, switches, solenoids, and fuses.

EFFECTIVE DATE: AUGUST 1, 1977

Pigtails are the wires that are provided by a device manufacturer to connect the device into the electrical circuit. Pigtails are usually electrically connected internally and led through a protective covering to be connected to electrical service conductors. Examples of electrical devices that are commonly equipped with pigtails are:

Cabin lighting fixtures
Navigation light fixtures
Blowers
Bilge Pumps
Horns
Searchlights
Indicator Lights
In-line fuses
Switches
Solenoids

The regulation exempts pigtails that are less than 7 inches in length from only the following:

183.425	–	Conductors: General
183.430	–	Conductors in Circuits of Less than 50 Volts
183.435	–	Conductors in Circuits of 50 Volts or More
183.455	–	Overcurrent Protection: General

To determine the length of pigtails measure the length of conductors that are visible external to the device, i.e. from the point on an electrical component where the conductors pass through a shell or housing to their end. This length must be less than 7 inches if the pigtails are to be excepted from these requirements. The portions of the conductors inside the component are not part of this pigtail length.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(g) "SAE" means Society of Automotive Engineers, Inc. SAE standards in this subpart may be examined at Coast Guard Headquarters, Room 4314, Trans Point Building, 2100–2nd Street SW, Washington, DC 20590 and may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

EFFECTIVE DATE: AUGUST 1, 1977

The following SAE standards are referenced in this Regulation.

SAE J378b "Marine Engine Wiring", dated November 1976. Within this standard reference is made to ASTM D573, "Test for Rubber Deterioration in an Air Oven" reapproved in 1972. Applies to 183.430.

SAE J557 "High Tension Ignition Cable", dated January 1968. Applies to 183.440.

SAE J1127 "Battery Cable", dated November 1975. Applies to 183.430.

SAE J1128 "Low Tension Primary Cable", dated November 1975. Applies to 183.430.

The following SAE standards are referenced in this Compliance Guldeline.

SAE J1171 "External Ignition Protection of Marine Electrical Devices". Applies to 183.410.

SAE J1191 "High Tension Ignition Cable Assemblies". Applies to 183.440.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(h) "Sheath" means a material used as a continuous protective covering, such as electrical tape, molded rubber, molded plastic, or flexible tubing, around one or more insulated conductors.

EFFECTIVE DATE: AUGUST 1, 1977

A "sheath" is a flexible continuous covering as distinguished from a "conduit" or "duct" which is a rigid continuous covering. As the regulation states a "sheath" may be a continuous wrapping of electrical tape, molded (or extruded) rubber or plastic, or flexible tubing (sometimes referred to as "spaghetti").

A "sheath" may be used around one or a number of conductors, which may or may not be different gauges. Each of the conductors must be insulated, that is the sheath is NOT to take the place of a conductors insulation.

A "sheath" does not have to hold the conductors tightly bonded together so that individual conductors cannot move in relation to each other. A "sheath" is generally used as a convenient means of grouping conductors to maintain a neat appearance as the conductors are run throughout the boat.

A "sheath" does not provide an alternate to the support requirements of 183.445. A sheath of conductors must be supported at the required 18 inch intervals.

IT'S THE LAW

183.402 DEFINITIONS

As used in this subpart –

(i) "UL" means Underwriters Laboratories, Inc. UL standards in this subpart may be examined at Coast Guard Headquarters, Room 4314, Trans Point Building, 2100–2nd Street SW, Washington, DC 20590 and may be obtained from Underwriters Laboratories, Inc., 207 East Ohio Street, Chicago, IL 60611.

EFFECTIVE DATE: AUGUST 1, 1977

The following UL standard is referenced in this Regulation.

UL 83 (also ANSI C33.80-1976) "Standard for Thermoplastic Insulated Wires", dated July 8, 1976. Applies to 183.435.

The following UL standard is referenced in this Compliance Guideline.

UL 1500 "Standard Test Procedure for Ignition Protection". Applies to 183.410.

IT'S THE LAW

183.405 GENERAL

Each electrical component on a boat to which this subpart applies must meet the requirements of this subpart unless the component is part of an outboard engine or is part of portable equipment.

EFFECTIVE DATE: AUGUST 1, 1977

The boat manufacturer is required to certify his boat as complying with this standard, not the manufacturer of each component. Component parts of outboard engines and portable equipment, such as a self-contained gasoline engine-generator unit, are not covered by these regulations.

The EQUIPMENT STANDARDS of this regulation appear to impose requirements, and consequently certification responsibilities, on component manufacturers. This is not the case. The boat manufacturer is the responsible party under these regulations and he must certify compliance.

Purchase orders can stipulate that component manufacturers assure compliance which a boat manufacturer may choose to recognize as supporting evidence in certifying the entire electrical system. Recognized, acceptable marine listings or labels may be used as supporting evidence of compliance. However, this does not relieve the boat manufacturer of certification responsibility.

MANUFACTURER REQUIREMENTS

IGNITION PROTECTION

GROUNDING

BATTERIES

CONDUCTORS: GENERAL

CONDUCTORS IN CIRCUITS OF LESS THAN 50 VOLTS

CONDUCTORS IN CIRCUITS OF 50 VOLTS OR MORE

SECONDARY CIRCUITS OF IGNITION SYSTEMS

CONDUCTORS: SUPPORT AND PROTECTION

CONDUCTORS: TERMINATION

OVERCURRENT PROTECTION: GENERAL

OVERCURRENT PROTECTION: SPECIAL APPLICATIONS

IT'S THE LAW

183.410 IGNITION PROTECTION

(a) Each electrical component must not ignite a propane gas and air mixture that is 4.25 to 5.25 percent propane gas by volume surrounding the electrical component when it is operated at each of its manufacturer rated voltages and current loadings, unless it is isolated from gasoline fuel sources, such as engines, and valves, connections, or other fittings in vent lines, fill lines, distribution lines or on fuel tanks, in accordance with paragraph (b) of this section.

EFFECTIVE DATE: AUGUST 1, 1978

An electrical component that is "ignition protected" is capable of operating in an explosive environment without igniting that environment. "Ignition protection" of electrical devices is accomplished by the use of seals, flame arresters and potting or a combination of such means.

To determine if a component is "ignition protected" there are a number of test procedures available that are acceptable to the US Coast Guard. For details of these test procedures refer to the following:

SAE J1171 "External Ignition Protection of Marine Electrical Devices".

UL 1500 "Standard Test Procedure for Ignition Protection".

US Coast Guard "USCG Compliance Test Procedure, Electrical System Standard". Copies of this standard are available from:

National Technical Information Service
Springfield, VA 22151

In general the tests are conducted in an explosion chamber containing an explosive atmosphere, defined by the regulation as a 4.25 to 5.25 percent mixture by volume of propane gas and air. The mixture is introduced into the component where internal sparking occurs, or is induced, so that an explosion is evident within the component. An internal explosion must NOT ignite the explosive atmosphere surrounding the device, in order for the component to pass the test. To assure compliance of a component this sequence is repeated 50 times.

The regulation also provides a means whereby electrical components NEED NOT be "ignition protected". If the electrical component is installed in a boat and is isolated from gasoline engines and gasoline fuel system components, except for uninterrupted runs of fuel lines, then the electrical component does NOT need to be ignition protected. Isolation of electrical components is discussed in the following Section of 183.410.

DO YOU COMPLY

Is each electrical component:

Ignition protected, or Isolated? ( )

IT'S THE LAW

183.410 IGNITION PROTECTION

(b) An electrical component is isolated from a gasoline fuel source if –

(I) A bulkhead that meets the requirements of paragraph (c) of this section is between the electrical component and the gasoline fuel source.

EFFECTIVE DATE: AUGUST 1, 1978

Isolation of an electrical component may be accomplished in a number of ways:

(1) Bulkheads
(2) Decks or special enclosures
(3) Open space with 2 feet minimum distance

This discussion deals with "Bulkheads". The next two sections discuss the other means.

A bulkhead is a vertical wall-like structure that may run transversely or longitudinally in a boat. Bulkheads are used both for strength and to separate a boat into different use areas, such as engine room, fuel tank compartment, living space, storage compartment, etc. By taking advantage of the location of bulkheads and installing electrical components accordingly, it may be possible to use non-ignition protected electrical components in many installations. Figures 3, 4, 5, and 6 depict some typical boats and the use of bulkheads for isolation.

A bulkhead and deck may be combined to accomplish isolation, such as may be found in a cruising sailboat with quarter-berths running along the side of an engine compartment.

Specific details of the construction of a bulkhead including watertightness, openings, penetrations and structural extent are covered in 183.410(c) on page 24.

DO YOU COMPLY

Is each electrical component either isolated or ignition protected? ( )

IT'S THE LAW

183.410 IGNITION PROTECTION

(b) An electrical component is isolated from a gasoline fuel source if –

(2) The electrical component is –

(i) Lower than the gasoline fuel source and a means is provided to prevent fuel and fuel vapors that may leak from the gasoline fuel source from becoming exposed to the electrical component; or

(ii) Higher than the gasoline fuel source and a deck or other enclosure is between it and the gasoline fuel source; or

EFFECTIVE DATE: AUGUST 1, 1978

Isolation of an electrical component may be accomplished in a number of ways.

(1) Bulkheads
(2) Decks or special enclosures
(3) Open space with 2 feet minimum distance

This discussion deals with "Decks or special enclosures". The previous and next sections discuss the other means.

Isolation that separates an electrical component from a gasoline fuel source may be accomplished by a deck between the two or by means of an enclosure. Either the electrical component or the gasoline fuel source may be enclosed to accomplish isolation. Partial bulkheads and foot boards may serve to provide a means of isolation.

The electrical component may be installed lower or higher that the gasoline fuel source.

(1) If the electrical component is installed LOWER than the gasoline fuel source; then, the deck or enclosure used to create the isolation must prevent liquid fuel and fuel vapors from coming in contact with the electrical component.

(2) If the electrical component is installed HIGHER than the gasoline fuel source; then, there must be a deck or enclosure to create the isolation but it is not necessary that it be liquid or vapor tight. Fuel vapors are heavier than air and would tend to collect below the isolation deck or enclosure. Should it be obvious in an installation that fuel vapors could surround an electrical component, then good practice would be to make the deck or enclosure an isolation barrier or select ignition protected electrical components.

Figures 3, 4, 5, 6, and 7 depict some typical boats and the use of decks and enclosures for isolation. Decks and bulkheads may be combined to accomplish isolation, such as may be found in a cruising sailboat with quarter-berths running along the side of an engine compartment.

DO YOU COMPLY

Is each electrical component either isolated or ignition protected? ( )

IT'S THE LAW

183.410 IGNITION PROTECTION

(b) An electrical component is isolated from a gasoline fuel source if –

(3) The space between the electrical component and the gasoline fuel source is at least two feet and the space is open to the atmosphere.

EFFECTIVE DATE: AUGUST 1, 1978

Isolation of an electrical component may be accomplished in a number of ways:

(1) Bulkheads
(2) Decks or special enclosures
(3) Open space with 2 feet minimum distance

This discussion deals with "Open space with 2 feet minimum distance". The previous two sections discuss the other means.

Ignition protection is NOT required for electrical components that are at least two feet from a gasoline fuel source and the space containing the electrical component and fuel source is open to the atmosphere. The term "open to the atmosphere" is defined as there being at least 15 square inches of unobstructed area into the compartment in question for every cubic foot of compartment volume. Open boats, such as runabouts, whose engine is aft and the fuel tank is located aft or far enough forward to meet the two feet distance provision, will be able to use non-ignition protected electrical components in their instrument panel. Figure 8 depicts a typical open boat whose bow compartment is open to the atmosphere and a 2 foot distance is maintained between electrical components and the gasoline fuel source. Figure 4 shows a saddle tank installation with a 2 foot distance between electrical components and the gasoline fuel source.

DO YOU COMPLY

Is each electrical component either isolated or ignition protected? **( )**

IT'S THE LAW

183.410 IGNITION PROTECTION

(c) Each bulkhead required by paragraph (b) (1) of this section must –

(1) Separate the electrical component from the gasoline fuel source and extend both vertically and horizontally the distance of the open space between the fuel source and the ignition source;

(2) Resist a water level that is 12 inches high or one-third of the maximum height of the bulkhead, whichever is less, without seepage of more than one-quarter fluid ounce of fresh water per hour; and

(3) Have no opening located higher than 12 inches or one-third the maximum height of the bulkhead, whichever is less, unless the opening is used for the passage of conductors, piping, ventilation ducts, mechanical equipment, and similar items, or doors, hatches, and access panels, and the maximum annular space around each item or door, hatch or access panel must not be more than one-quarter inch.

EFFECTIVE DATE: AUGUST 1, 1978

To effectively separate a gasoline fuel source and an electrical component by a bulkhead, the regulation has established certain criteria covering the following:

(1) – the extent of the bulkhead both horizontally and vertically.
(2) – the water-resistant height of the bulkhead and permitted seepage.
(3) – openings through the bulkhead below the water-resistant height.
(4) – openings through the bulkhead above the water-resistant height.

Figures 9 and 10 depict a typical bulkhead installation with a number of the regulated items noted.

BULKHEAD EXTENT – A bulkhead intended to isolate an electrical component from a gasoline fuel source must basically close off one space from another. The bulkhead must be fitted closely to the sides, bottom and top of the space or compartment. There should be no vent holes, corners snipped off, limber holes or hand holes in this bulkhead. It should reach the full width and the full height of the space being closed off.

WATER-RESISTANT HEIGHT – The lower portion of the bulkhead must be essentially water-resistant. Any openings for piping, wiring, ducting, controls, etc. must have a sealed fitting used to prevent seepage around the item going through the bulkhead. The total seepage permitted for the entire area of the bulkhead below the height is a maximum of one quarter ounce, (approximately one-half tablespoon) of fresh water per hour.

The water-resistant height to be used for a particular bulkhead is based on the maximum height of the bulkhead. The water-resistant height is the lesser of 12 inches or 1/3 the maximum height of the bulkhead. For example, if the total height from the lowest point of the bulkhead to the uppermost point of the bulkhead is 33 inches, then the water-resistant height is 11 inches. If the total height is 42 inches, then the water-resistant height is 12 inches because 12 inches is less than 1/3 of 42 inches.

OPENINGS BELOW THE WATER-RESISTANT HEIGHT – Bulkheads used for isolation may have openings for; wiring, piping, ducts, controls, doors, hatches, access panels, drains, and other such purposes, but each opening located below the water-resistant height of the bulkhead must be sealed or have a fitting to minimize seepage. Doors and hatches or portions thereof must also be fitted or sealed to minimize seepage. The maximum seepage permitted for all openings and along the edges of the bulkhead may not exceed a total of one quarter ounce, (approximately one-half tablespoon) of fresh water per hour.

OPENINGS ABOVE THE WATER-RESISTANT HEIGHT – Openings above the water-resistant height are permitted for; wiring, piping, ducts, controls, doors, hatches, access panels, drains, and other such purposes, but each opening must not have more than a 1/4 inch wide space around whatever passes through the bulkhead, such as piping, wiring, ducts, controls, etc. Hatches, doors, access panels, etc. must be fitted so there is not more than 1/4 inch clearance around them when they are closed or in place, except if they extend below the water-resistant height (see above).

SPECIAL NOTE: *Concerning drain holes in isolation bulkheads, the US Coast Guard has developed the following compliance policy:*

Any hole installed for drainage in an isolation bulkhead must be fitted with a plug or sealing device that is intended to be in place when the boat is being used. The plug or sealing device must be attached to the drain fitting or the bulkhead near the drain hole so it will not be lost. It must be understood that when this drain hole is open the isolation integrity of the bulkhead has been breached causing a potentially hazardous condition. It is the responsibility of the boat manufacturer to make this intent known to the consumer via means such as labeling, information in a boat owners manual, etc.

DO YOU COMPLY

Is each bulkhead used for isolation –

(1) – between the gasoline fuel source and the electrical component? ( )

(2) – extend to a full width and height? ( )

(3) – water-resistant, except for permitted seepage, to the lesser height of 12 inches or one-third the maximum height of the bulkhead? ( )

Is the annular space around hatches, doors, access panels etc. or items passing through the bulkhead and located above the water-resistant height of the bulkhead not more than 1/4 inch. ( )

FIGURE 3 ISOLATION OF ELECTRICAL COMPONENTS

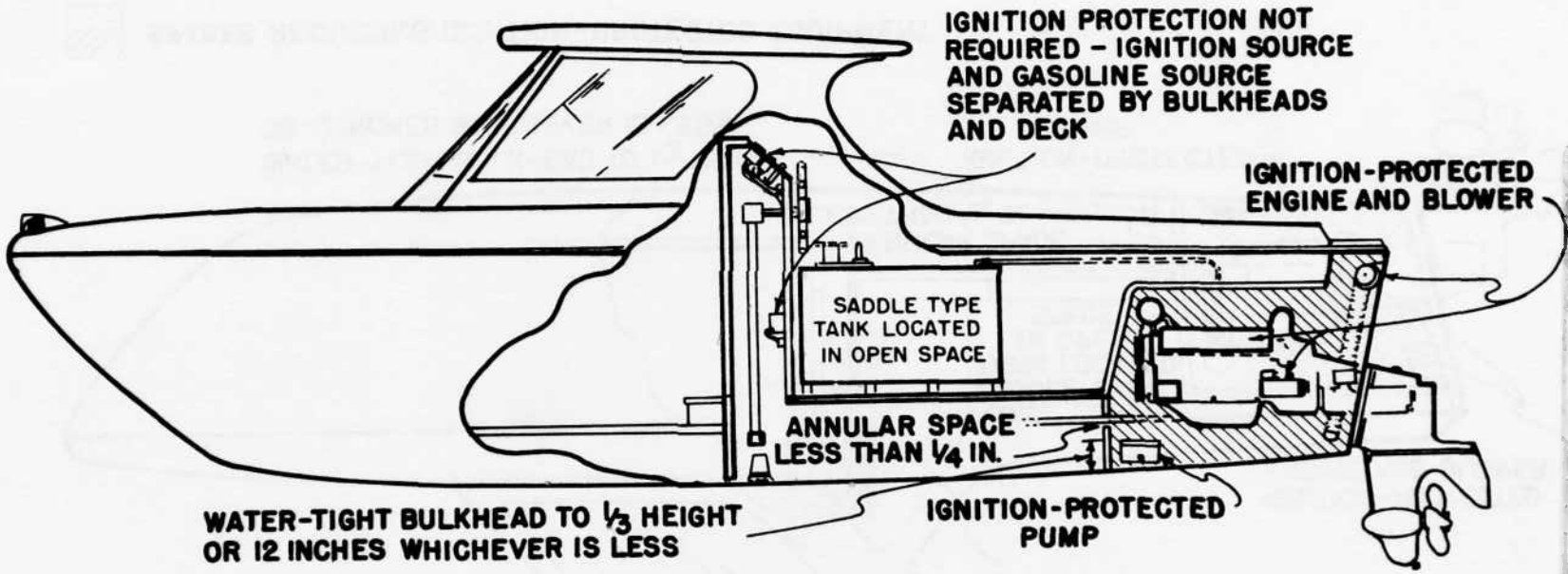


FIGURE 4 ISOLATION OF ELECTRICAL COMPONENTS

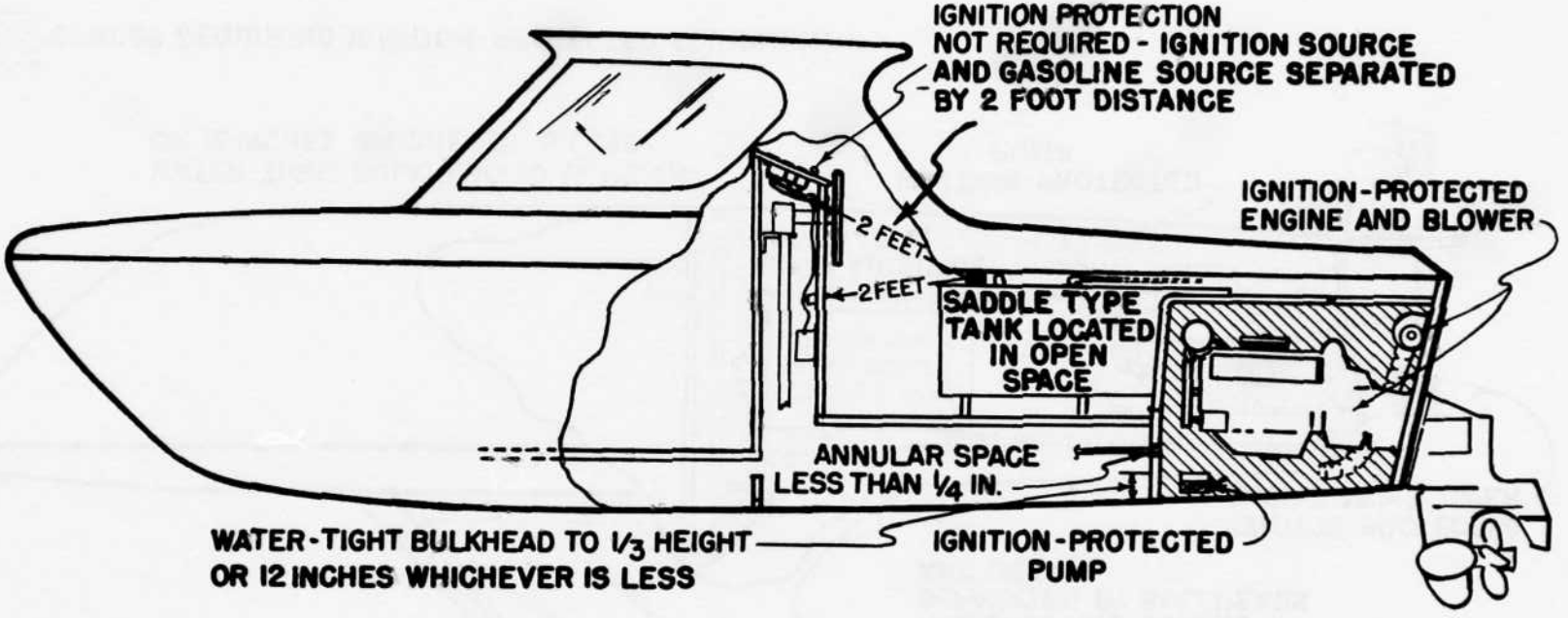


FIGURE 5 ISOLATION OF ELECTRICAL COMPONENTS

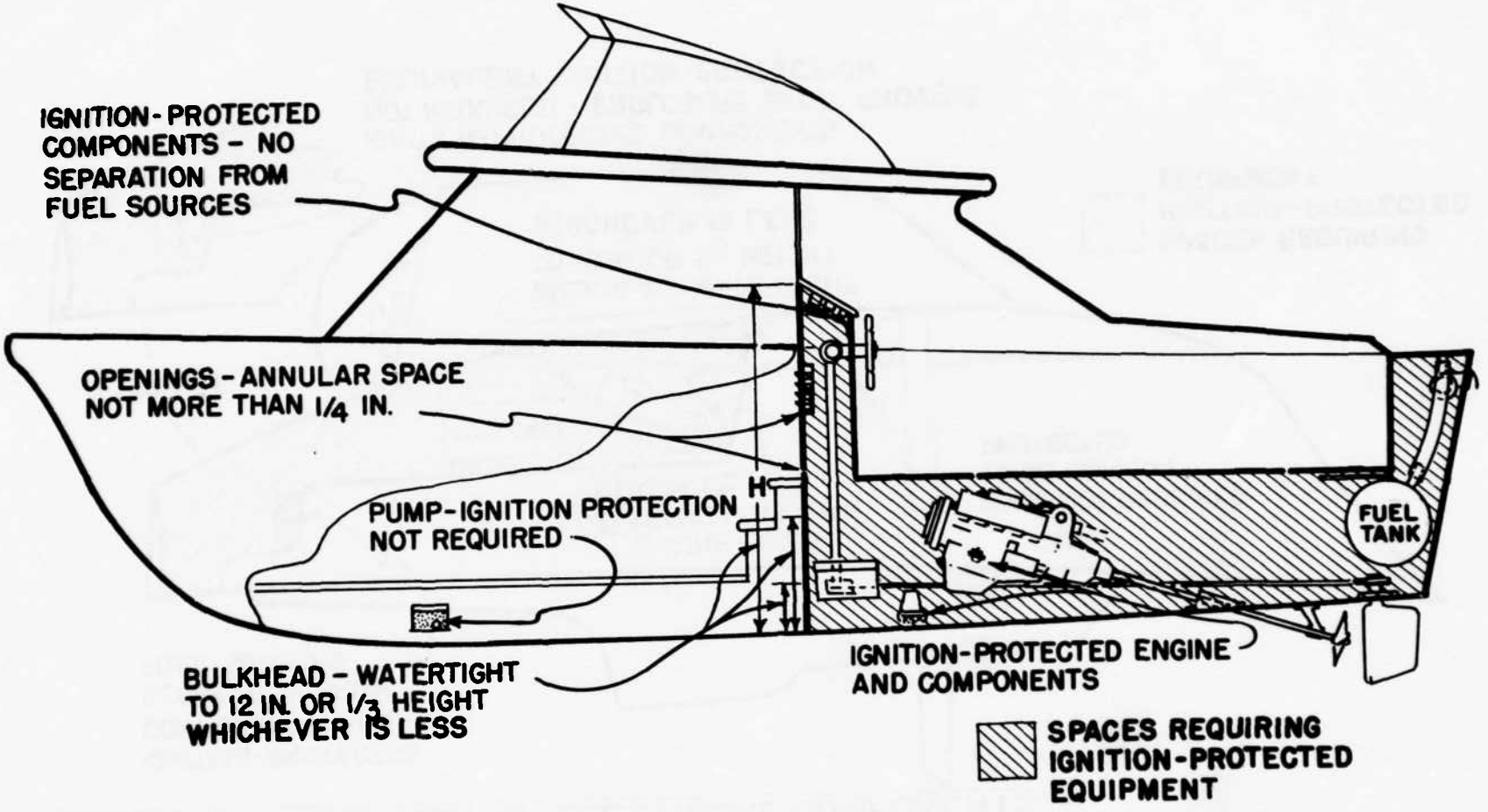


FIGURE 6 ISOLATION OF ELECTRICAL COMPONENTS

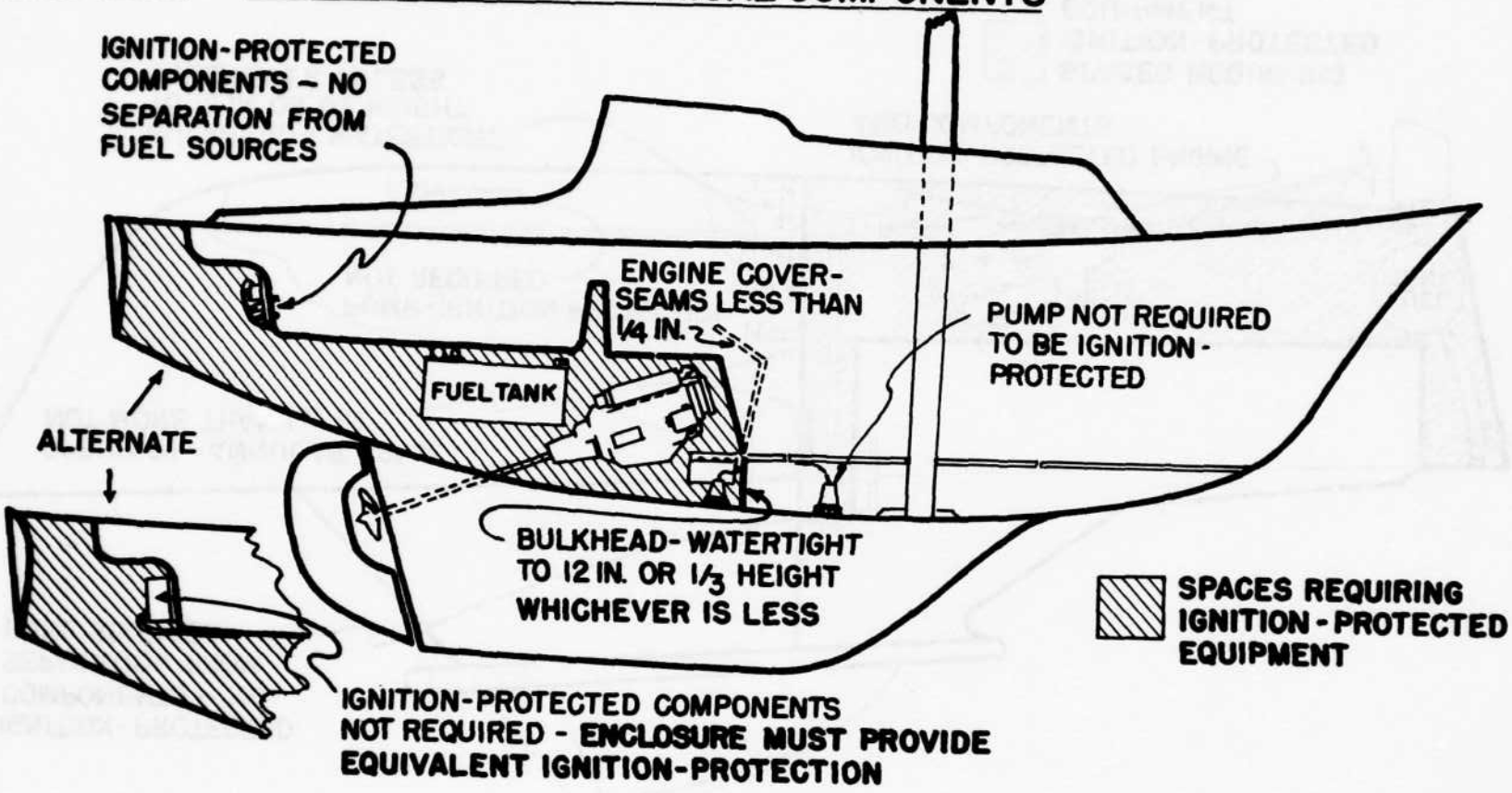


FIGURE 7 ISOLATION OF ELECTRICAL COMPONENTS

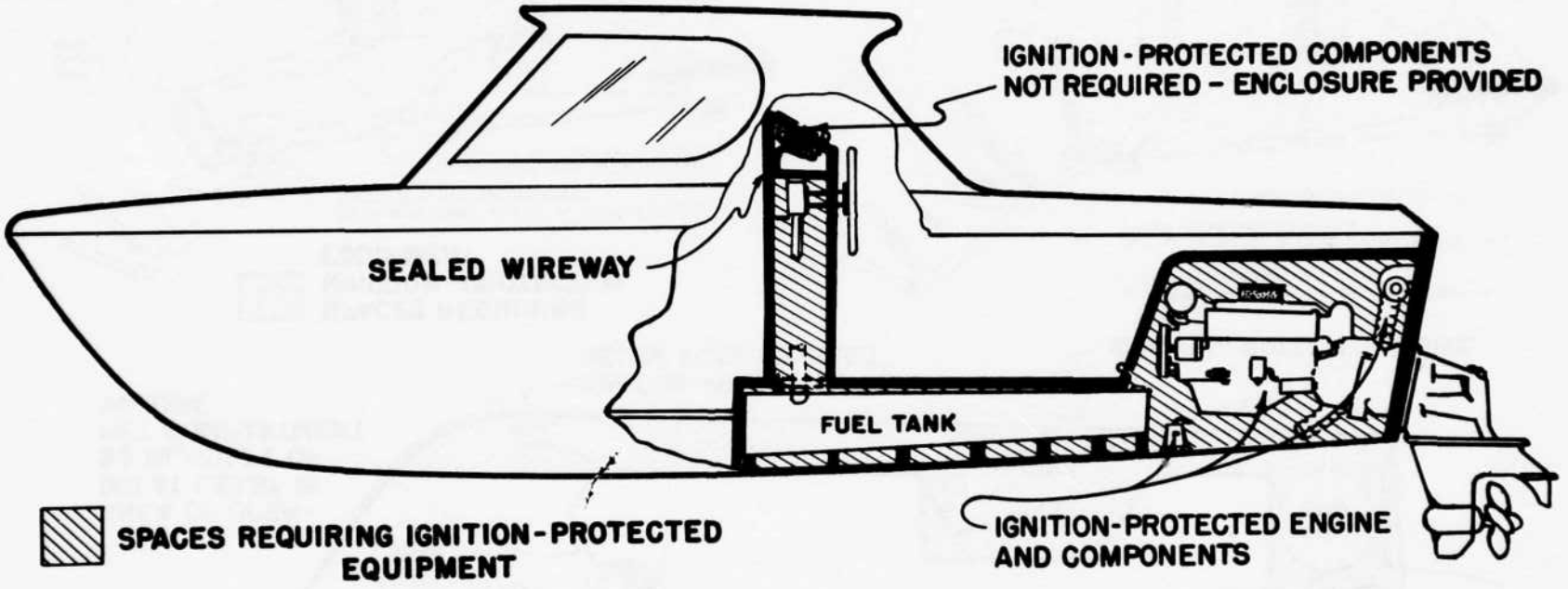


FIGURE 8 ISOLATION OF ELECTRICAL COMPONENTS

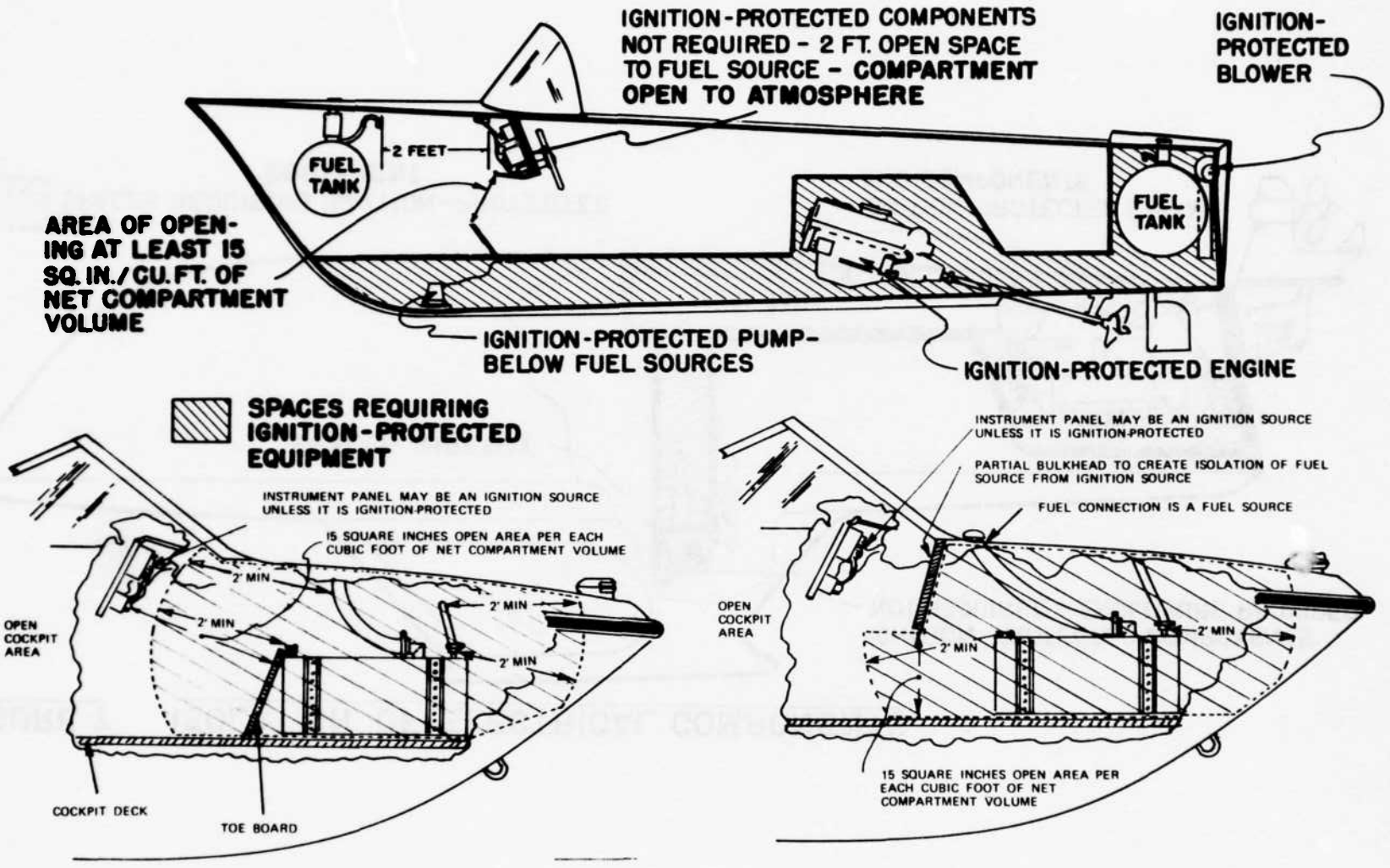
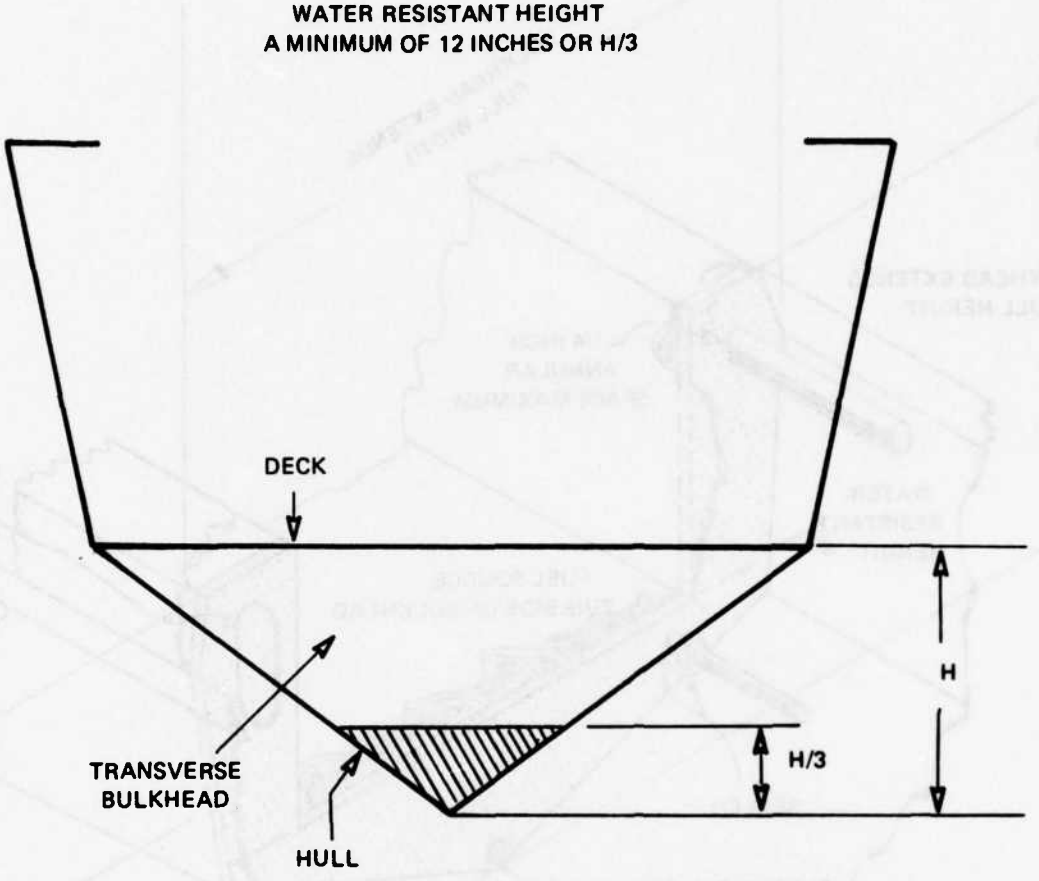


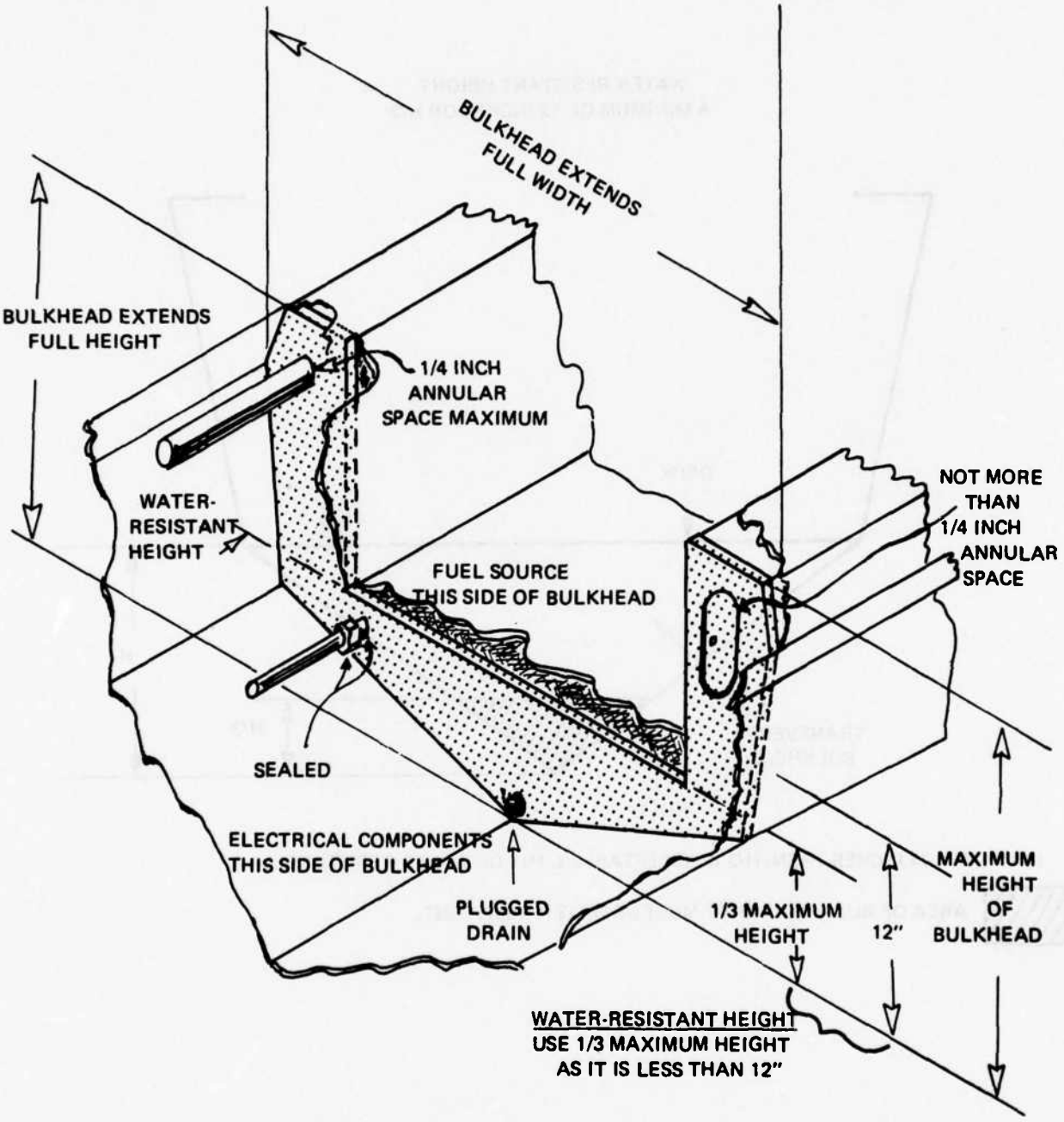
FIGURE 9 -- ISOLATION BULKHEAD REQUIREMENTS



IF: H = 24 INCHES THEN: H/3 IS ACCEPTABLE LIMIT OF WATER RESISTANCE.

AREA OF BULKHEAD THAT MUST BE WATER RESISTANT.

FIGURE 10 -- BULKHEADS



NOTE: (1) Seepage of not more than one-quarter fluid ounce per hour permitted below the water-resistant height. This includes bulkhead fastenings and space around hatches, doors, access panels etc. and items passing through the bulkhead.

(2) Openings above the water-resistant height may not have more than 1/4 inch annular space around items passing through the openings.

183.415 GROUNDING

If a boat has more than one gasoline engine, grounded cranking motor circuits must be connected to each other by a common conductor circuit that can carry the starting current of each of the grounded cranking motor circuits.

EFFECTIVE DATE: FEBRUARY 1, 1978

The purpose of this requirement is to prevent accidental passage of battery supply current through fuel systems and smaller electrical conductors that may be common to the engines. If one of the grounded cranking motor circuits accidentally opens due to corrosion, vibration, etc., the accidental passage of current could melt fuel lines or burn up conductors. Both of these hazards could lead to fire and explosion accidents. The common conductor circuit referred to in the regulation is a circuit made up of jumper conductors and may include a common bus bar.

In a two engine installation a jumper conductor will satisfy compliance if connected between the negative sides of the grounded cranking motor circuits.

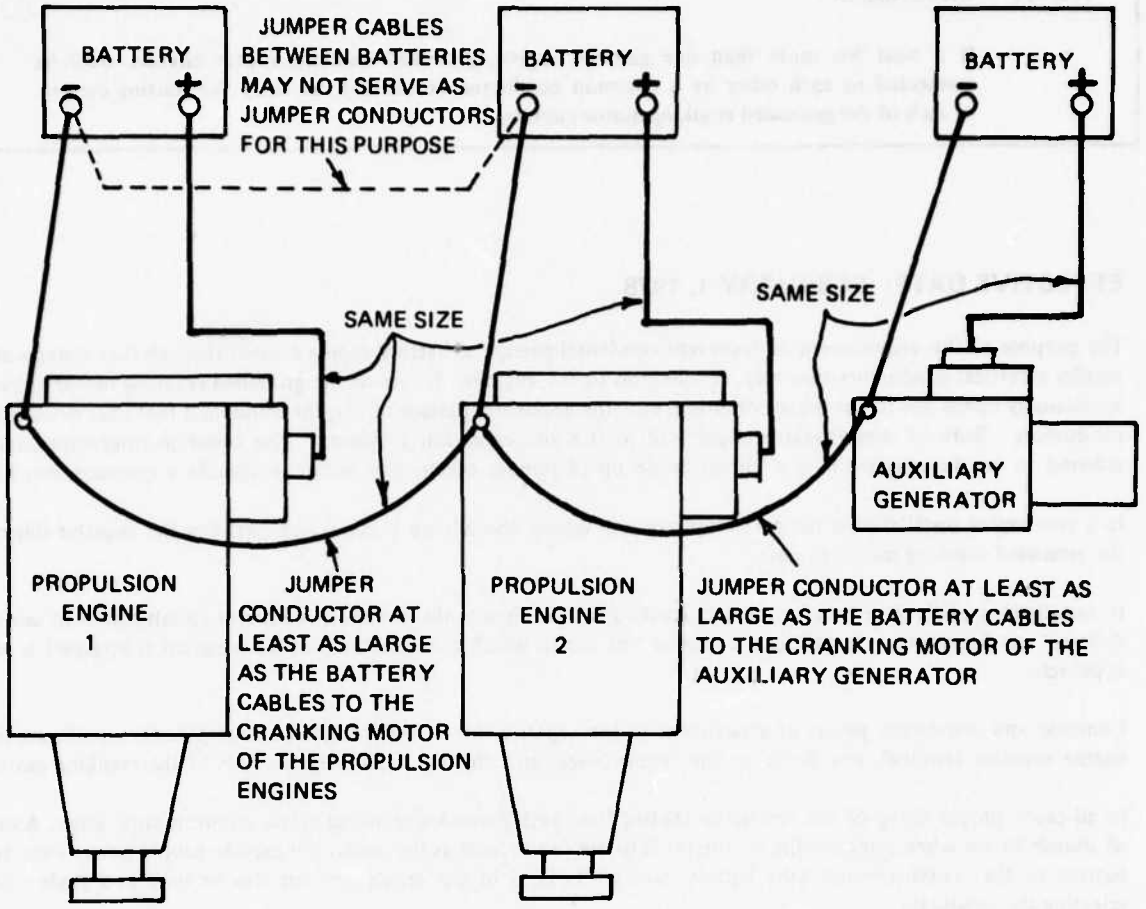
In installations of three or more grounded cranking motor circuits the common conductor circuit can be of several different configurations. Installing a common bus bar to which a conductor from each circuit is attached is one approach.

Common and convenient points of attachment to the negative side of the grounded cranking motor circuits are the engine negative terminal, any point on the engine block, and directly to the negative side of the cranking motor.

In all cases, proper sizing of the conductor leading from each grounded cranking motor circuit is imperative. A rule of thumb to use when selecting the conductor is to use one as large as the conductor used to supply power from the battery to the cranking motor (the battery cable). Table 5 of the regulation can also be used as a guide when selecting the conductor.

If there are two or more individual starting battery installations and the negative terminals are connected by a common conductor, that common conductor does not satisfy this grounding requirement. Additional conductor(s) are necessary. Figure 11 diagrams typical circuits.

FIGURE 11 – CRANKING MOTOR CIRCUITS



DO YOU COMPLY

If there is more than one grounded cranking motor circuit:

(1) Are the grounded cranking motor circuits connected by a common conductor circuit? ( )

(2) Is the common conductor circuit properly sized to carry the starting current of each of the grounded cranking motor circuits? ( )

IT'S THE LAW

183.420 BATTERIES

(a) Each installed battery must not move more than one inch in any direction when a pulling force of 90 pounds or twice the battery weight, whichever is less, is applied through the center of gravity of the battery as follows:

(1) Vertically for a duration of one minute.

(2) Horizontally and parallel to the boat's center line for a duration of one minute fore and one minute aft.

(3) Horizontally and perpendicular to the boat's center line for a duration of one minute to starboard and one minute to port.

EFFECTIVE DATE: AUGUST 1, 1977

If a battery was allowed to reposition itself indiscriminately at the will of the forces that occur when a vessel (especially the smaller, quicker reacting type) is operated in inclement weather, or while being transported overland in its fitted-out condition, the battery could become damaged. If the battery casing ruptures, the electrolyte may run out. If a battery terminal loosens, poor contact or sparking could occur. The electrolyte is usually sulphuric acid which can severely attack many metals and other materials. Such attack on fuel system components has the potential of developing the hazardous condition of leaking fuel. Movement of a battery could cause the battery terminal to come in contact with grounded items, resulting in sparking.

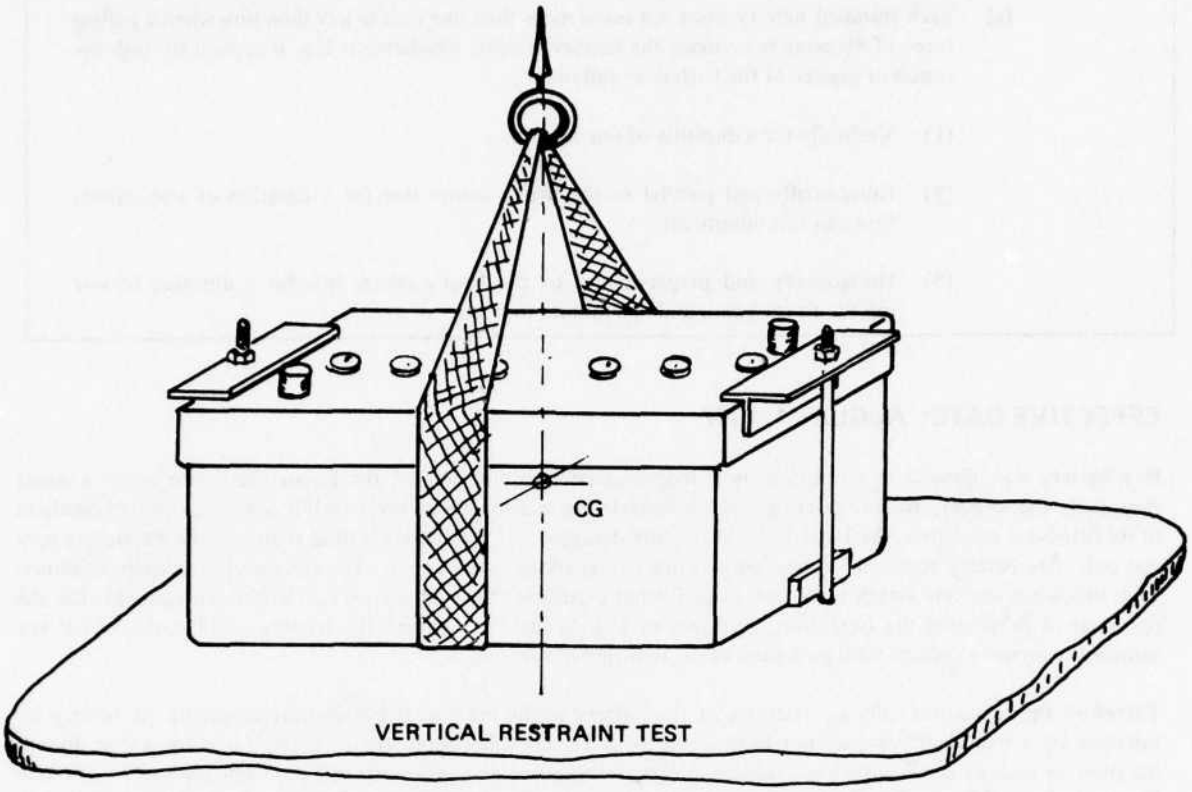
Therefore, the regulation calls for restraint of the battery in the horizontal and vertical directions. A battery as installed by a manufacturer may not move more than 1 inch when subjected to a test force for a one minute duration in each of three directions; vertical, horizontal-fore and aft, and horizontal-port and starboard. The test force selected is 90 pounds, which is approximately twice the weight of the popular size of marine battery used in small boats which may be subject to high accelerations. Larger boats frequently use larger heavier batteries and usually experience relatively lower accelerations. For this reason the 90 pounds was selected as the maximum that needed to be applied. For batteries weighing less than 45 pounds, a force of twice the battery weight is specified. This test force is to be applied through the center of gravity of the battery.

The commercially available plastic battery boxes may be used to install a battery, however, it may be necessary to provide means within the battery box to prevent excess movement of the battery in the box. The materials used for restraining battery movement within a battery box should be selected with regard to potential deterioration by the electrolyte. It must be noted that a battery box must be fastened in such a manner that the battery installation will comply with this section of the regulation.

It is recommended that the use of materials to wedge the battery in a battery box be described in the boat owners manual to affirm its intended use.

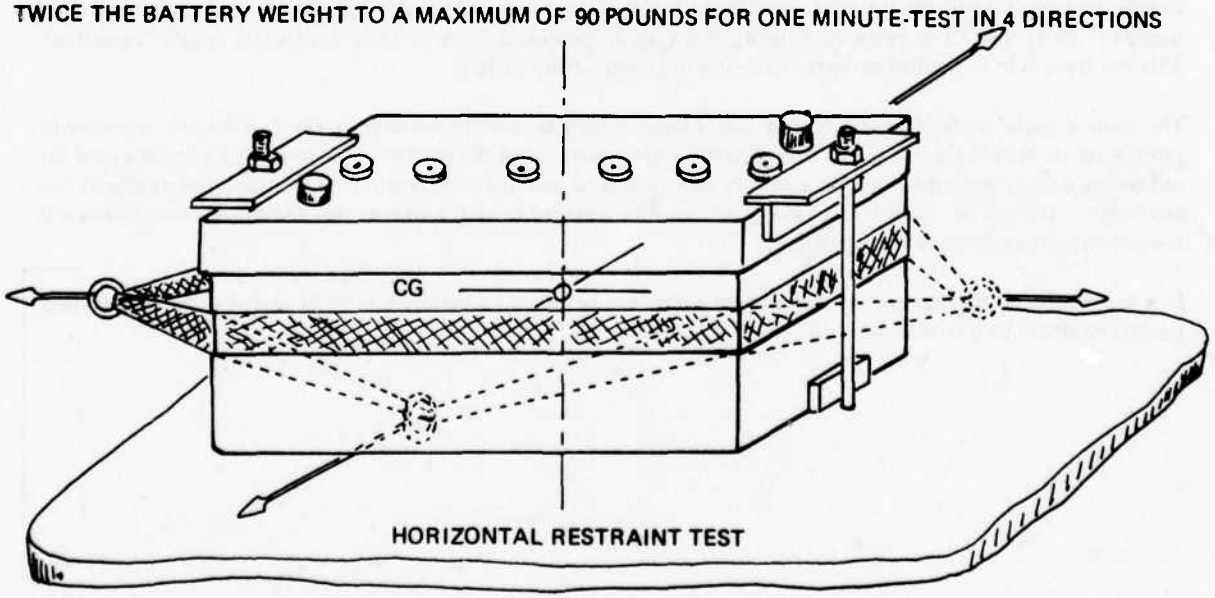
FIGURE 12 – BATTERY RESTRAINT TEST

TWICE THE BATTERY WEIGHT TO A MAXIMUM OF 90 POUNDS FOR ONE MINUTE



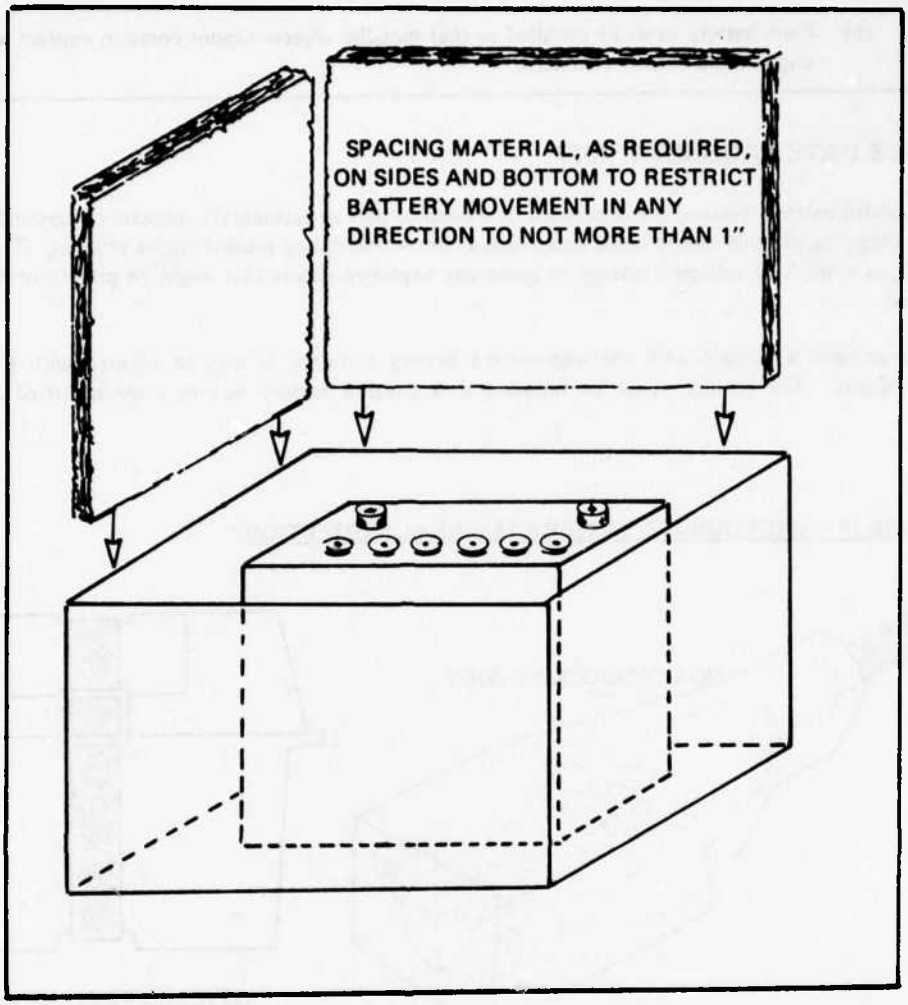
VERTICAL RESTRAINT TEST

TWICE THE BATTERY WEIGHT TO A MAXIMUM OF 90 POUNDS FOR ONE MINUTE-TEST IN 4 DIRECTIONS



HORIZONTAL RESTRAINT TEST

FIGURE 13 - INSTALLATION IN A BATTERY BOX



DO YOU COMPLY

Is the battery installed so that it will not move more than 1 inch in any direction when a force of 90 pounds or twice the battery's weight, whichever is less, is applied for one minute each:

Vertically	**( )**
Horizontally – Forward	**( )**
Horizontally – Aft	**( )**
Horizontally – Port	**( )**
Horizontally – Starboard	**( )**

IT'S THE LAW

183.420 BATTERIES

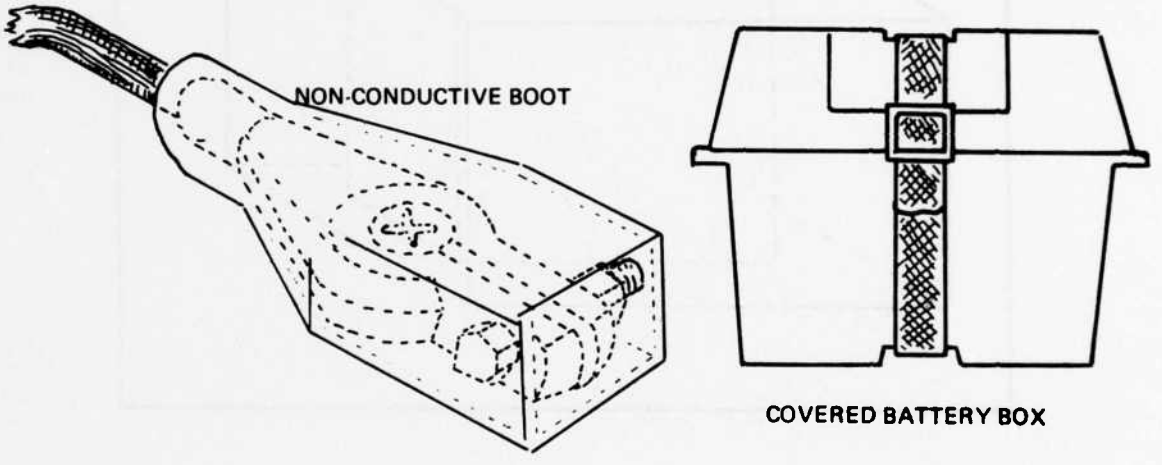
(b) Each battery must be installed so that metallic objects cannot come in contact with the ungrounded battery terminals.

EFFECTIVE DATE: AUGUST 1, 1977

If an ungrounded battery terminal is left exposed, it is possible that an accidental connection to ground could occur. The use or dropping of tools nearby could make such a connection during routine engine servicing. This connection could result in a spark of sufficient energy to ignite any explosive vapors that might be present or might start an electrical fire.

To prevent accidental contact with the ungrounded battery terminal, it may be covered with a boot or non-conductive shield. The battery could be installed in a covered battery box or a special fitted compartment.

FIGURE 14 - UNGROUNDED BATTERY TERMINAL PROTECTION



DO YOU COMPLY

Have precautions been taken to prevent metallic objects from coming in contact with the ungrounded battery terminal when the battery is in its installed position? ( )

183.420 BATTERIES

(c) Each metallic fuel line and fuel system component within 12 inches and above the horizontal plane of the battery top surface as installed must be shielded with dielectric material.

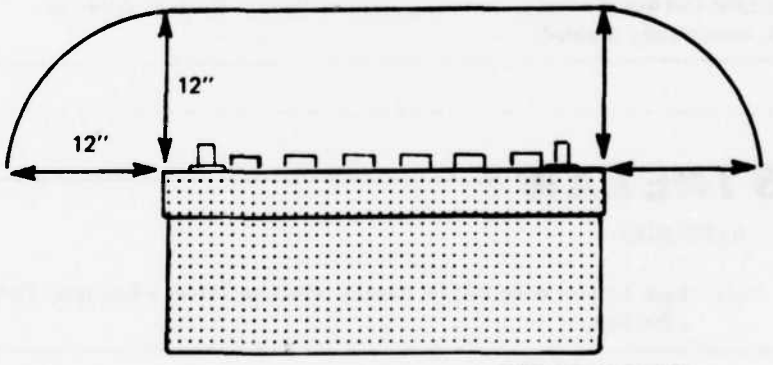
EFFECTIVE DATE: AUGUST 1, 1977

Metallic fuel lines and fuel system components are usually electrically grounded, whether intentionally or just because they are connected to an engine or a fuel tank. If, while servicing the battery, installing or removing it, a tool should contact the ungrounded terminal and the fuel line or component, a spark could occur, or a hole could be burned into the fuel line, creating a hazardous condition, fire or explosion. Also, the act of installing or removing a battery with exposed terminals could result in both terminals contacting a fuel line or component which could result in a similar hazard.

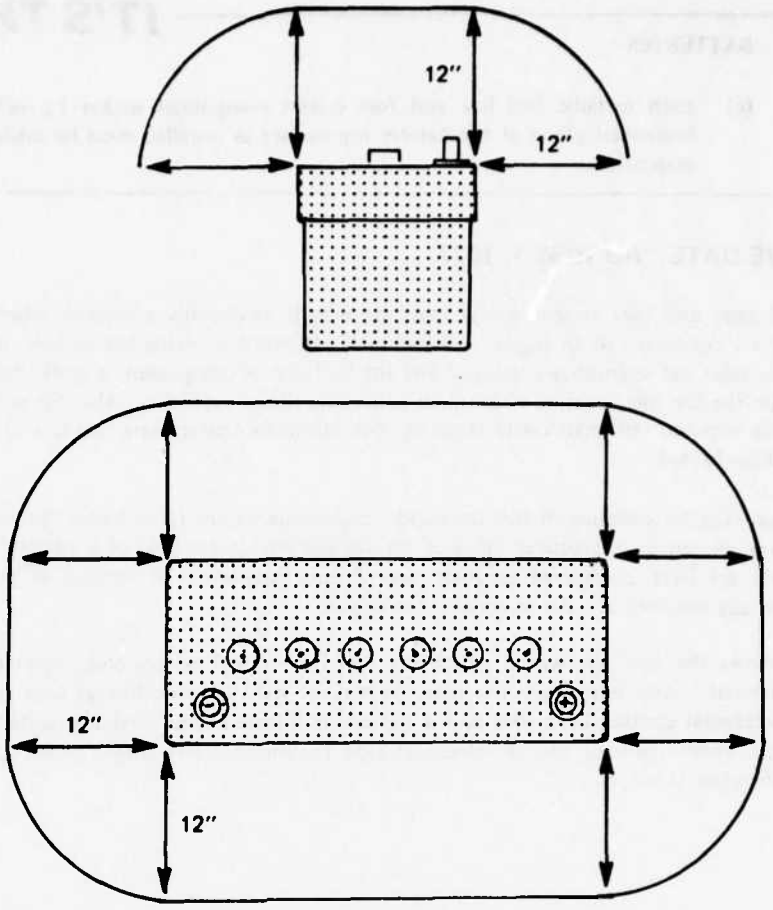
The regulation calls for shielding of fuel lines and components within 12 inches of the top surface of the battery. 12 inches was chosen as a practical distance for installation or removal of a battery. Terminal insulation or battery covers are NOT considered adequate since during installation or removal of a battery, these protective devices are usually removed in order to connect the cables.

Figure 15 shows the envelope within which any fuel line or fuel system component must be shielded using a dielectric material. Any non-conductive material may be used for shielding as long as it is durable enough to withstand accidental contact by a tool or the battery terminals during servicing, installation or removal. Some materials that appear suitable include electrical tape (continuous wrapping), plastic pipe or tubing, dielectric sheathing, fiberglass, wood, etc.

FIGURE 15 – DIELECTRIC SHIELDING ENVELOPE



(SEE NEXT PAGE)



DO YOU COMPLY

Is each metallic fuel line and fuel system component, within the envelope shown in Figure 13, dielectrically shielded? ( )

IT'S THE LAW

183.420 BATTERIES

(d) Each battery must not be directly above or below a fuel tank, fuel filter, or fitting in a fuel line.

EFFECTIVE DATE: AUGUST 1, 1977

Certain components of the fuel system have been identified as the prime sources of potential leakage. These items are the fuel tank, fuel filter and fuel line fittings. Also many fuel filters are equipped with drain plugs for servicing.

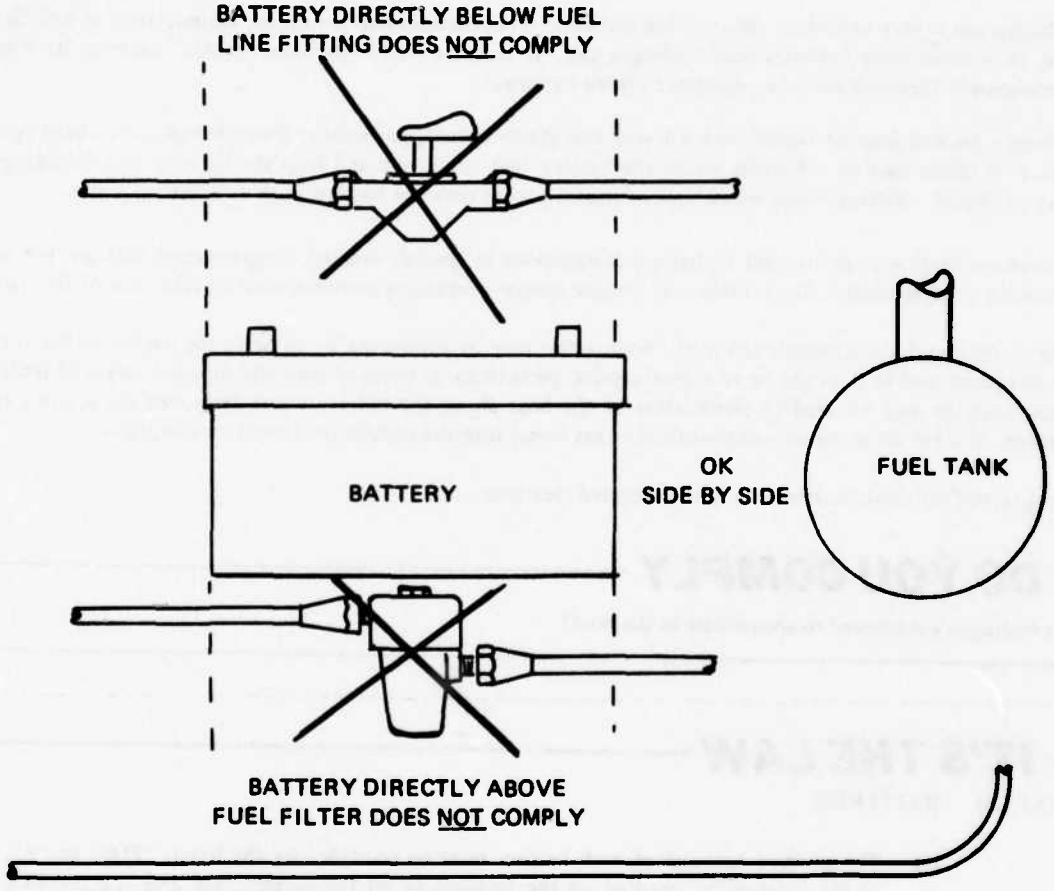
If a battery is installed directly below these fuel items, there is a potential of gasoline leaking on the battery, possibly attacking the battery case material.

If a battery is installed directly above these fuel items, leaking electrolyte may attack fuel system components creating fuel leakage.

Also of concern is the servicing of fuel system components if a battery is installed directly above or below them. Accidental short circuiting may occur while servicing installing or removing a battery.

This does not prohibit a battery from being installed directly above or below an uninterrupted fuel line; however, if this fuel line is within the 12 inch envelope of the top surface of the battery it must be shielded dielectrically as required in 183.420(c) and discussed on page 41.

FIGURE 16 – BATTERY LOCATION vs FUEL SYSTEM



DO YOU COMPLY

Is each battery installed away from:

Directly ABOVE a fuel tank, fuel filter and fuel line fittings? ( )
Directly BELOW a fuel tank, fuel filter and fuel line fittings? ( )

IT'S THE LAW

183.420 BATTERIES

(e) Hydrogen gas discharged by a battery must not accumulate in the boat.

EFFECTIVE DATE: AUGUST 1, 1977

Hydrogen gas is very explosive. Boat design and battery installations that permit the accumulation of hydrogen gas must be avoided since batteries emit hydrogen gas. It must be noted that even "sealed" batteries have venting provisions and therefore must be considered vented batteries.

Hydrogen gas will disperse rapidly and will seek exit at any opening particularly through high or overhead openings, since it is lighter-than-air. Pockets above the battery that could trap and hold the lighter-than-air, hydrogen gas must be vented. Battery boxes whose cover forms a pocket over the battery likewise must be vented.

Particular attention must be paid to battery installations in special, isolated compartments that are not part of ventilated compartments. These areas may require special ventilation considerations to take care of the batteries.

If in doubt about gas accumulation in the boat, a test may be conducted by charging the battery in the boat with the boat equipped as it would be in normal service, particularly in terms of normally supplied means of ventilation. A gas analyzer may be used to check areas of the boat above the battery where hydrogen gas accumulation is possible. If there are no dangerous quantities of gas found then the installation should be acceptable.

Best practice is to install batteries in well ventilated locations.

DO YOU COMPLY

Is hydrogen gas allowed to accumulate in the boat? ( )

IT'S THE LAW

183.420 BATTERIES

(f) The positive terminal of each battery must be identified by the letters "POS" or "P", or the symbol "+" marked on the terminal or on the battery case near the terminal.

EFFECTIVE DATE: AUGUST 1, 1977

Many electrical devices require connections to be made with a specific polarity in order to function properly. Identification of the battery terminals will aid in preventing possible short circuiting or burning of electrical

components which could occur if polarity is reversed. In multiple battery installations, reversed polarity connection of a battery could create a fire and explosion hazard with an explosive force equal to the combined force of discharging the connected batteries simultaneously.

The regulation calls for identification of at least the positive battery terminal and offers a number of ways to accomplish said identification. Any one or more of the following designators may be used:

"POS", "P" or "+"

These designators may be marked on or molded with, the positive battery terminal or the battery case near the positive battery terminal.

Color markings and terminal size distinction are acceptable and do exist on batteries, however these identification techniques must be IN ADDITION TO the required markings.

DO YOU COMPLY

Is the positive battery terminal or battery case near the positive battery terminal marked "POS", "P", or "+"? ( )

IT'S THE LAW

183.420 BATTERIES

(g) Each battery terminal connector must not depend on spring tension for its mechanical connection to the terminal

EFFECTIVE DATE: AUGUST 1, 1977

The integrity of battery terminal connections is very important in consideration of preventing sparking, and overheating of the terminal. These failures of a battery terminal connection could result in a fire and explosion hazard.

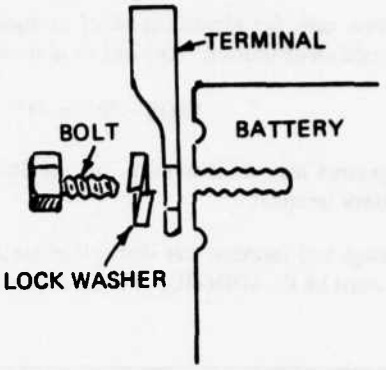
Therefore the regulation, in prohibiting spring-type battery terminal connectors, is seeking the use of mechanical connection means that are not likely to loosen due to vibration.

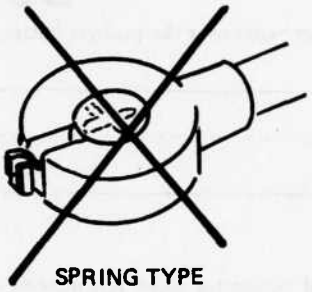
There are basically two types of battery terminal connections in prevalent use. They are the clamp type, and the bolt-on type. Figure 17 depicts these types and a spring-type which is PROHIBITED.

FIGURE 17 – BATTERY TERMINAL CONNECTIONS

CLAMP TYPE

BOLT-ON TYPE





SPRING TYPE
(PROHIBITED)

DO YOU COMPLY

Is each battery *terminal connector provided* with a mechanical terminal connection means that does NOT depend on spring tension? ( )

IT'S THE LAW

183.425 CONDUCTORS: GENERAL

(a) Each conductor must be insulated, stranded copper.

EFFECTIVE DATE: FEBRUARY 1, 1978

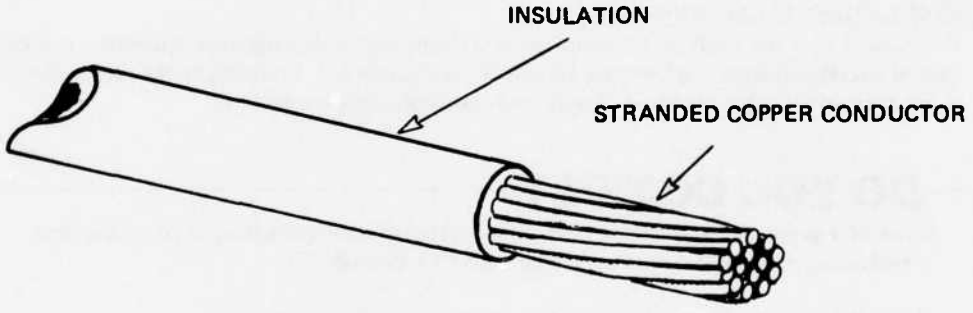
Each conductor must be insulated with an insulation compound meeting:

183.430 (if less than 50 volts). See page 50, or
183.435 (if 50 volts or more). See page 51

The conductor construction is to be stranded to resist failure due to vibration and flexing. Copper is specified for best conductivity and corrosion resistance.

REGULATORY EXCEPTIONS 183.425(g) –
This section does not apply to communication systems; electronic navigation equipment; resistance conductors that control circuit amperage; high voltage secondary conductors and terminations that are in ignition systems; pigtails of less than seven inches of exposed length; and cranking motor conductors.

FIGURE 18 – INSULATED, STRANDED COPPER CONDUCTOR



DO YOU COMPLY

The conductor insulation material conforms to either 183.430 or 183.435 depending on the voltage application (less than 50 volts or 50 volts and more). ( )

The construction is of stranded copper. ( )

NOTE PERMITTED EXCEPTIONS

IT'S THE LAW

183.425 CONDUCTORS: GENERAL

(b) Except for intermittent surges each conductor must not carry a current greater than the specified in Table 5 for the conductor's gauge and temperature rating.

(c) For conductors in engine spaces, amperages must be corrected by the appropriate correction factor in Note 1 of Table 5.

EFFECTIVE DATE: FEBRUARY 1, 1978

The current values referred to in Table 5 are constant or steady values as compared with various types of intermittent higher currents which may occur momentarily in circuits, such as those associated with stern-drive trimming devices or electrical motor starting situations. To select a conductor size use the maximum steady state load.

Due to engine heat, the ambient temperature in engine spaces is usually higher than in other spaces of a boat. Wiring in and passing through engine spaces must be able to operate in these spaces. The ampacity values of Table 5 are based on an ambient temperature of 30°C (86°F) which is considered reasonable for use on boats except in engine spaces. The correction factors of Note 1 under Table 5 convert the ampacities of Table 5 to acceptable values in an ambient temperature of 50°C (122°F). This higher temperature has been selected as satisfactory for engine spaces.

Tables, 5A through 5E, are supplied to eliminate the need for calculating the corrections to Table 5 (See Notes 1 and 2 under Table 5), see pages 55 to 59 . The values are already corrected. Sample calculations appear on pages 60 to 62.

REGULATORY EXCEPTIONS 183.425(g) –
This section does not apply to communication systems; electronic navigation equipment; resistance conductors that control circuit amperage; high voltage secondary conductors and terminations that are in ignition systems; pigtails of less than seven inches of exposed length; and cranking motor conductors.

DO YOU COMPLY

Conductor gauge and temperature ratings are selected to carry current equal to, or less than, the values given in Table 5 (and associated Tables 5A through 5E). ( )

(Note difference in allowed amperage for outside and inside engine spaces)

NOTE PERMITTED EXCEPTIONS

IT'S THE LAW

183.425 CONDUCTORS: GENERAL

(d) Each conductor in a multiconductor sheath must be at least a No. 18 AWG conductor.

(e) Each conductor installed separately must be at least a No. 16 AWG conductor.

(f) Each No. 18 AWG conductor in a multiconductor sheath may not extend out of the sheath more than 30 inches.

EFFECTIVE DATE: FEBRUARY 1, 1978

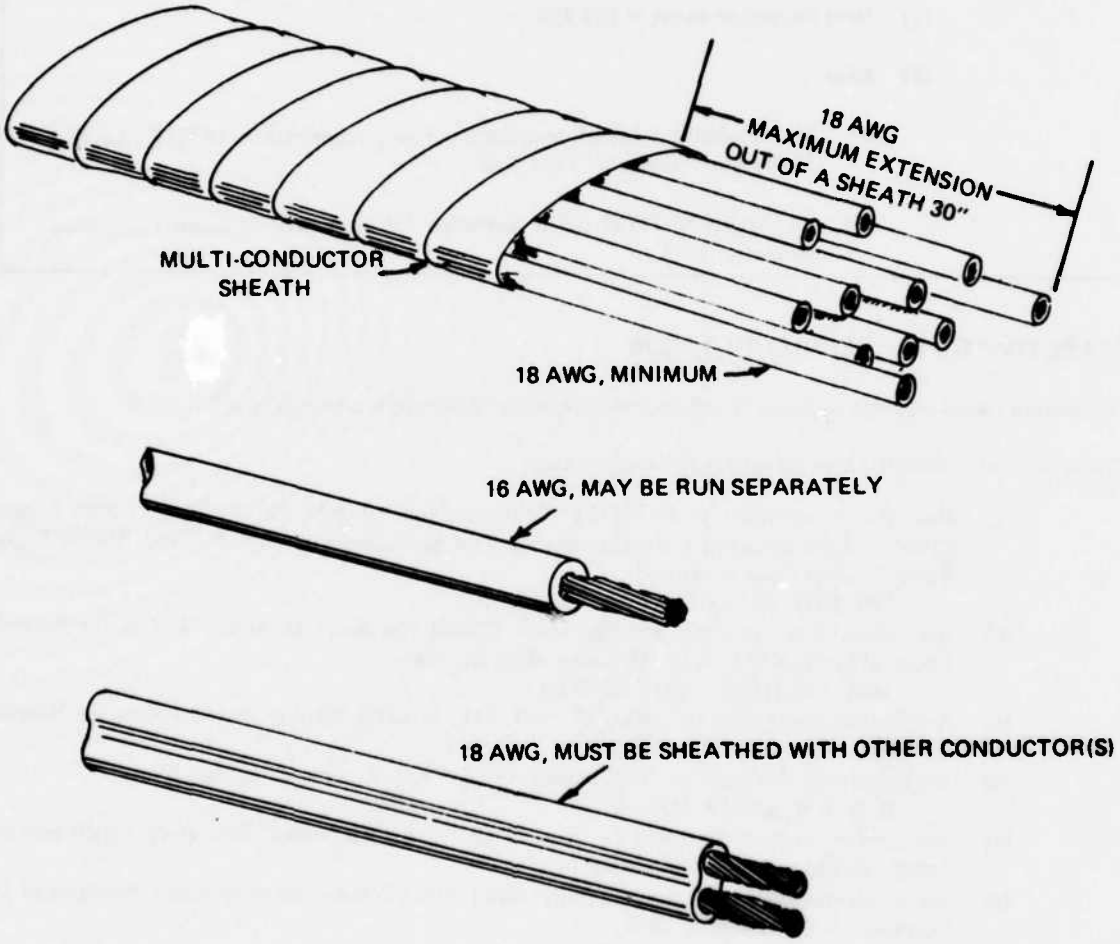
A conductor smaller than 16 AWG may not be used by itself. An 18 AWG is the smallest conductor permitted, except for the regulatory exceptions, and it must be in a multiconductor (2 or more conductors) sheath.

An 18 AWG conductor is limited to a 30 inch length from the end of a sheath. (See Figure 19)

NOTE: SAE conductor sizes are acceptable in place of AWG.

REGULATORY EXCEPTIONS 183.425(g) –
This section does not apply to communciation systems; electronic navigation equipment; resistance conductors that control circuit amperage; high voltage secondary conductors and terminations that are in ignition systems; pigtails of less than seven inches of exposed length; and cranking motor conductors.

FIGURE 19 – PERMITTED CONDUCTOR SIZE



DO YOU COMPLY

No conductor smaller than No. 16 AWG is used separately. ( )

Any No. 18 AWG conductor used is protected in a suitable multiconductor sheath and does not extend out of this sheath more than 30 inches. ( )

NOTE PERMITTED EXCEPTIONS

IT'S THE LAW

183.430 CONDUCTORS IN CIRCUITS OF LESS THAN 50 VOLTS

(a) Each conductor in a circuit that has a nominal voltage of less than 50 volts must –

(1) Meet the requirements of 183.435; or

(2) Meet –

(i) The insulating material temperature rating requirements of SAE Standard J378b dated November 1976; and

(ii) SAE Standard J1127 dated November 1975, or SAE Standard 1128 dated November 1975.

EFFECTIVE DATE: FEBRUARY 1, 1978

This section allows alternate choices of conductor requirements for circuits less than 50 volts.

Conductors for circuits less than 50 volts may be used if they:

(a) Meet the requirements of SAE J1127 "Battery Cable" or SAE J1128 "Low Tension Primary Cable" and the insulating material temperature rating requirements of SAE J378b "Marine Engine Wiring" such as those designated:
GPT, HDT, SGT, STS, HTS, and SXL, or;

(b) Are classified as "moisture retardant" and "flame retardant" in Article 310 of the National Electrical Code (NFPA 70-1975), such as those designated:
THW, TW, THWN, XHHW, MTW, or;

(c) Are flexible cords type SO, STO, ST, SJO, SJT, or SJTO listed in Article 400 of the National Electrical Code (NFPA 70-1975), or;

(d) Are conductors that meet the IEEE Standard 45-1971, such as those designated:
R, B, T, V, AV, TA, M, S, *or;*

(e) Are conductors that are listed for marine use by an independent laboratory which provides listing, labeling and follow-up service, or;

(f) Are conductors that meet the mechanical water absorption and flame retardant standards of UL Standard 83, dated July 8, 1976.

Conductors for circuits of 50 volts or more must comply with 183.435. See page 51.

Conductors, as purchased, many times do not indicate whether or not they conform with the above requirements and standards. If the conductors or their packaging are not so marked then an alternate means of assurance of compliance should be obtained. Certification of compliance by a vendor is one acceptable means.

REGULATORY EXCEPTIONS 183.430(b) –
This section does not apply to communication systems; electronic navigation equipment; resistance conductors that control circuit amperage; and pigtails of less than seven inches of exposed length.

DO YOU COMPLY

All conductors for use in circuits of less than 50 volts meet 183.435, ( )

OR

Meet the requirements of SAE Standard J1127 dated November 1975 or SAE Standard J1128 dated November 1975 and the insulating material temperature rating requirements of SAE Standard J378b dated November 1976. ( )

NOTE PERMITTED EXCEPTIONS

IT'S THE LAW

183.435 CONDUCTORS IN CIRCUITS OF 50 VOLTS OR MORE

(a) Each conductor in a circuit that has a nominal voltage of 50 volts or more must be –

(1) A conductor that has insulation listed and classified moisture resistant and flame retardant in Article 310, NFPA No. 70-1975, National Electric Code 1975;

(2) A flexible cord type SO, STO, ST, SJO, SJT, or SJTO listed in Article 400, NFPA No. 70-1975, National Electric Code 1975;

(3) A conductor that meets IEEE Standard 45-1971, dated December 3, 1970;

(4) A conductor listed for marine use by an independent testing laboratory which provides listing, labeling, and follow up service; or

(5) A conductor that meets the mechanical water absorption and flame retardent standards of UL Standard 83, dated July 8, 1976.

EFFECTIVE DATE: FEBRUARY 1, 1978

This section applies only to wiring in the 50 volts and over category. However, conductors meeting any one of these 5 alternate requirements will also qualify for use in the UNDER 50 volt category. The alternating current (AC) systems of 120 and 240 volts are the systems normally in use on boats to which these requirements apply.

Paragraphs (a)(1), (a)(3), (a)(4), and (a)(5) apply to conductors in general while paragraph (a)(2) applies specifically to various types of FLEXIBLE CORDS.

Conductors for circuits of 50 volts or more may be used if they:

(a) Are classified as "moisture retardant" and "flame retardant" in Article 310 of the National Electrical Code (NFPA 70-1975), such as those designated:
THW, TW, THWN, XHHW, MTW, or;

(b) Are flexible cords type SO, STO, ST, SJO, SJT, or SJTO listed in Article 400 of the National Electrical Code (NFPA 70-1975), or;

(c) Are conductors that meet the IEEE Standard 45-1971, such as those designated: R, B, T, V, AV, TA, M, S, or;

(d) Are conductors that are listed for marine use by an independent laboratory which provides listing, labeling and follow-up service, or;

(e) Are conductors that meet the mechanical water absorption and flame retardant standards for UL Standard 83, dated July 8, 1976.

Conductors, as purchased, many times do not indicate whether or not they conform with the above requirements and standards. If the conductors or their packaging are not so marked then an alternate means of assurance of compliance should be obtained. Certification of compliance by a vendor is one acceptable means.

REGULATORY EXCEPTIONS 183.435(c) –
This section does not apply to communication systems; electronic navigation equipment; resistance conductors that control circuit amperage; conductors in secondary circuits or ignition systems; and pigtails of less than seven inches of exposed length.

DO YOU COMPLY

All conductors used in the 50 volts and over category meet one or more of the 5 alternate requirements of this section. ( )

All conductors used in the UNDER 50 volt category meet one or more of the 5 alternate requirements of this section or the requirements of 183.430. ( )

NOTE PERMITTED EXCEPTIONS

IT'S THE LAW

183.435 CONDUCTORS IN CIRCUITS OF 50 VOLTS OR MORE

(b) Where the nominal circuit voltage of each of three or more current carrying conductors in a duct, bundle, or cable is 50 volts or more, the amperages of each of those conductors must not exceed the value in Table 5 multiplied by the correction factor in Note 2 to Table 5 for the number of conductors that carry 50 volts or more.

EFFECTIVE DATE: FEBRUARY 1, 1978

To select the right bundling correction factor, count only the current carrying conductors that are in circuits of 50 volts or more. Other conductors in the same bundle do not have to be counted, such as grounding conductors, conductors from senders to gauges and conductors in low voltage circuits less than 50 volts. For example if a bundle contains a total of ten conductors:

3	– 12 volt system
1	– oil pressure gauge
2	– grounding conductors
4	– 120 volt AC system
10	

then the bundling factor is based on the 4 current-carrying-conductors in the 120 volt AC system.

Tables 5B through 5E contain tabulated values for allowable amperage in 50 volts and over circuitry in which 3 or more current-carrying-conductors are bundled. See the correct Table for the bundling selected, 5B: 3, 5C: 4-6, 5D: 7-24, 5E: 25 or more. These Tables incorporate all necessary correction factors as noted in both 183.425 and 183.435. Also see sample calculations on pages 60 to 62.

REGULATORY EXCEPTIONS 183.435(c) –

This section does not apply to communication systems; electronic navigation equipment; resistance conductors that control circuit amperage; conductors in secondary circuits or ignition systems; and pigtails of less than seven inches of exposed length.

DO YOU COMPLY

All current carrying conductors used in the 50 volt and over category and bundled (or incorporated in a duct or cable) in quantities of 3 or more do not exceed the maximum limits allowed in Table 5 when all correction factors are incorporated. (Relating Table 5B through 5E are provided for ease in complying.) ( )

NOTE PERMITTED EXCEPTIONS

IT'S THE LAW

183.435

TABLE 5.—*Allowable amperage of conductors*

Conductor size (AWG)	Temperature rating of conductor insulation						
	60° C (140° F)	75° C (167° F)	80° C (176° F)	90° C (194° F)	105° C (221° F)	125° C (257° F)	200° C (392° F)
18	10	10	15	20	20	25	25
16	15	15	20	25	25	30	35
14	20	20	25	30	35	40	45
12	25	25	35	40	45	50	55
10	40	40	50	55	60	70	70
8	55	65	70	70	80	90	100
6	80	95	100	100	120	125	135
4	105	125	130	135	160	170	180
3	120	145	150	155	180	195	210
2	140	170	175	180	210	225	240
1	165	195	210	210	245	265	280
0	195	230	245	245	285	305	325
00	225	265	285	285	330	355	370
000	260	310	330	330	385	410	430
0000	300	360	385	385	445	475	510

NOTES

1. See the following table:

Temperature rating of conductor	60° C (140° F)	75° C (167° F)	80° C (176° F)	90° C (194° F)	105° C (221° F)	125° C (257° F)	200° C (392° F)
	0.58	0.75	0.78	0.82	0.85	0.89	1.00

2. See the following table:

Number of current carrying conductors:	Correction factor
3	0.70
4 to 6	.60
7 to 24	.50
25 and above	.40

EFFECTIVE DATE: FEBRUARY 1, 1978

Table 5 is used to select the size of conductors. Correction factors are provided for conductors used in engine spaces (Note 1) and also for bundling of conductors used in circuits 50 volts and over (Note 2).

Tables 5A through 5E have been developed for this guideline, and include corrected values so it is not necessary to perform the calculations required if using Table 5. Select the proper Table according to the number of 50 volts or more current-carrying-conductors in a bundle and then read the wire gauge needed according to the temperature rating, location of the conductor and the circuit load. See sample calculations on pages 60 to 62.

Conductors, as purchased, many times do not display temperature ratings of conductor insulation. If the conductors or their packaging are not so marked then an alternate means of assurance of compliance should be obtained. Certification of compliance by a vendor is one acceptable means.

TABLE 5A
ALLOWABLE AMPERAGE OF CONDUCTORS FOR UNDER 50 VOLTS*
AND WHEN
NO MORE THAN 2 CONDUCTORS ARE BUNDLED FOR 50 VOLTS AND OVER

CONDUCTOR SIZE (AWG)	Temperature Rating of Conductor Insulation												
	60°C (140°F)		75°C (167°F)		80°C (176°F)		90°C (194°F)		105°C (221°F)		125°C (257°F)		200°C (392°F)
	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE OR INSIDE ENGINE SPACES
18	10	5.8	10	7.5	15	11.7	20	16.4	20	17.0	25	22.3	25
16	15	8.7	15	11.3	20	15.6	25	20.5	25	21.3	30	26.7	35
14	20	11.6	20	15.0	25	19.5	30	24.6	35	29.8	40	35.6	45
12	25	14.5	25	18.8	35	27.3	40	32.8	45	38.3	50	44.5	55
10	40	23.2	40	30.0	50	39.0	55	45.1	60	51.0	70	62.3	70
8	55	31.9	65	48.8	70	54.6	70	57.4	80	68.0	90	80.1	100
6	80	46.4	95	71.3	100	78.0	100	82.0	120	102.0	125	111.3	135
4	105	60.9	125	93.8	130	101.4	135	110.7	160	136.0	170	151.3	180
3	120	69.6	145	108.8	150	117.0	155	127.1	180	153.0	195	173.6	210
2	140	81.2	170	127.5	175	136.5	180	147.6	210	178.5	225	200.3	240
1	165	95.7	195	146.3	210	163.8	210	172.2	245	208.3	265	235.9	280
0	195	113.1	230	172.5	245	191.1	245	200.9	285	242.3	305	271.5	325
00	225	130.5	265	198.8	285	222.3	285	233.7	330	280.5	355	316.0	370
000	260	150.8	310	232.5	330	257.4	330	270.6	385	327.3	410	364.9	430
0000	300	174.0	360	270.0	385	300.3	385	315.7	445	378.3	475	422.8	510

-- There is NO LIMIT on conductors in a bundle for under 50 volts.

TABLE 5B
ALLOWABLE AMPERAGE OF CONDUCTORS FOR 50 VOLTS AND OVER WHEN 3 CONDUCTORS ARE BUNDLED

CONDUCTOR SIZE (AWG)	Temperature Rating of Conductor Insulation												
	60°C (140°F)		75°C (167°F)		80°C (176°F)		90°C (194°F)		105°C (221°F)		125°C (257°F)		200°C (392°F)
	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE OR INSIDE ENGINE SPACES
18	7.0	4.1	7.0	5.3	10.5	8.2	14.0	11.5	14.0	11.9	17.5	15.6	17.5
16	10.5	6.1	10.5	7.9	14.0	10.9	17.5	14.4	17.5	14.9	21.0	18.7	24.5
14	14.0	8.1	14.0	10.5	17.5	13.7	21.0	17.2	24.5	20.8	28.0	24.9	31.5
12	17.5	10.2	17.5	13.1	24.5	19.1	28.0	23.0	31.5	26.8	35.0	31.2	38.5
10	28.0	16.2	28.0	21.0	35.0	27.3	38.5	31.6	42.0	35.7	49.0	43.6	49.0
8	38.5	22.3	45.5	34.1	49.0	38.2	49.0	40.2	56.0	47.6	63.0	56.1	70.0
6	56.0	32.5	66.5	49.9	70.0	54.6	70.0	57.4	84.0	71.4	87.5	77.9	94.5
4	73.5	42.6	87.5	65.6	91.0	71.0	94.5	77.5	112.0	95.2	119.0	105.9	126.0
3	84.0	48.7	101.5	76.1	105.0	81.9	108.5	89.0	126.0	107.1	136.5	121.5	147.0
2	98.0	56.8	119.0	89.3	122.5	95.6	126.0	103.3	147.0	125.0	157.5	140.2	168.0
1	115.5	67.0	136.5	102.4	147.0	114.7	147.0	120.5	171.5	145.8	185.5	165.1	196.0
0	136.5	79.2	161.0	120.8	171.5	133.8	171.5	140.6	199.5	169.6	213.5	190.0	227.5
00	157.5	91.4	185.5	139.1	199.5	155.6	199.5	163.6	231.0	196.4	248.5	221.2	259.0
000	182.0	105.6	217.0	162.8	231.0	180.2	231.0	189.4	269.5	229.1	287.0	255.4	301.0
0000	210.0	121.8	252.0	189.0	269.5	210.2	269.5	221.0	311.5	264.8	332.5	295.9	357.0

TABLE 5C
ALLOWABLE AMPERAGE OF CONDUCTORS FOR 50 VOLTS AND OVER WHEN 4 TO 6 CONDUCTORS ARE BUNDLED

CONDUCTOR SIZE (AWG)	Temperature Rating of Conductor Insulation												
	60°C (140°F)		75°C (167°F)		80°C (176°F)		90°C (194°F)		105°C (221°F)		125°C (257°F)		200°C (392°F)
	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE OR INSIDE ENGINE SPACES
18	6.0	3.5	6.0	4.5	9.0	7.0	12.0	9.8	12.0	10.2	15.0	13.4	15.0
16	9.0	5.2	9.0	6.8	12.0	9.4	15.0	12.3	15.0	12.8	18.0	16.0	21.0
14	12.0	7.0	12.0	9.0	15.0	11.7	18.0	14.8	21.0	17.9	24.0	21.4	27.0
12	15.0	8.7	15.0	11.3	21.0	16.4	24.0	19.7	27.0	23.0	30.0	26.7	33.0
10	24.0	13.9	24.0	18.0	30.0	23.4	33.0	27.1	36.0	30.6	42.0	37.4	42.0
8	33.0	19.1	39.0	29.3	42.0	32.8	42.0	34.4	48.0	40.8	54.0	48.1	60.0
6	48.0	27.8	57.0	42.8	60.0	46.8	60.0	49.2	72.0	61.2	75.0	66.8	81.0
4	63.0	36.5	75.0	56.3	78.0	60.8	81.0	66.4	96.0	81.6	102.0	90.8	108.0
3	72.0	41.8	87.0	65.3	90.0	70.2	93.0	76.3	108.0	91.8	117.0	104.1	126.0
2	84.0	48.7	102.0	76.5	105.0	81.9	108.0	88.6	126.0	107.1	135.0	120.2	144.0
1	99.0	57.4	117.0	87.8	126.0	98.3	126.0	103.3	147.0	125.0	159.0	141.5	168.0
0	117.0	67.9	138.0	103.5	147.0	114.7	147.0	120.5	171.0	145.4	183.0	162.9	195.0
00	135.0	78.3	159.0	119.3	171.0	133.4	171.0	140.2	198.0	168.3	213.0	189.6	222.0
000	156.0	90.5	186.0	139.5	198.0	154.4	198.0	162.4	231.0	196.4	246.0	218.9	258.0
0000	180.0	104.4	216.0	162.0	231.0	180.2	231.0	189.4	267.0	227.0	285.0	253.7	306.0

TABLE 5D
ALLOWABLE AMPERAGE OF CONDUCTORS FOR 50 VOLTS AND OVER WHEN 7 TO 24 CONDUCTORS ARE BUNDLED

CONDUCTOR SIZE (AWG)	Temperature Rating of Conductor Insulation												
	80°C (140°F)		75°C (167°F)		80°C (176°F)		90°C (194°F)		105°C (221°F)		125°C (257°F)		200°C (392°F)
	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE OR INSIDE ENGINE SPACES
18	5.0	2.9	5.0	3.8	7.5	5.9	10.0	8.2	10.0	8.5	12.5	11.1	12.5
16	7.5	4.4	7.5	5.6	10.0	7.8	12.5	10.3	12.5	10.6	15.0	13.4	17.5
14	10.0	5.8	10.0	7.5	12.5	9.8	15.0	12.3	17.5	14.9	20.0	17.8	22.5
12	12.5	7.3	12.5	9.4	17.5	13.7	20.0	16.4	22.5	19.1	25.0	22.3	27.5
10	20.0	11.6	20.0	15.0	25.0	19.5	27.5	22.6	30.0	25.5	35.0	31.2	35.0
8	27.5	16.0	32.5	24.4	35.0	27.3	35.0	28.7	40.0	34.0	45.0	40.1	50.0
6	40.0	23.2	47.5	35.6	50.0	39.0	50.0	41.0	60.0	51.0	62.5	55.6	67.5
4	52.5	30.5	62.5	46.9	65.0	50.7	67.5	55.4	80.0	68.0	85.0	75.7	90.0
3	60.0	34.8	72.5	54.4	75.0	58.5	77.5	63.6	90.0	76.5	97.5	86.8	105.0
2	70.0	40.6	85.0	63.8	87.5	68.3	90.0	73.8	105.0	89.3	112.5	100.1	120.0
1	82.5	47.9	97.5	73.1	105.0	81.9	105.0	86.1	122.5	104.1	132.5	117.9	140.0
0	97.5	56.6	115.0	86.3	122.5	95.6	122.5	100.5	142.5	121.1	152.5	135.7	162.5
00	112.5	65.3	132.5	99.4	142.5	111.2	142.5	116.9	165.0	140.3	177.5	158.0	185.0
000	130.0	75.4	155.0	116.3	165.0	128.7	165.0	135.3	192.5	163.6	205.0	182.5	215.0
0000	150.0	87.0	180.0	135.0	192.5	150.2	192.5	157.9	222.5	189.1	237.5	211.4	255.0

TABLE 5E
ALLOWABLE AMPERAGE OF CONDUCTORS FOR 50 VOLTS AND OVER WHEN 25 OR MORE CONDUCTORS ARE BUNDLED

CONDUCTOR SIZE (AWG)	Temperature Rating of Conductor Insulation												
	60° C (140° F)		75° C (167° F)		80° C (176° F)		90° C (194° F)		105° C (221° F)		125° C (257° F)		200° C (392° F)
	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE ENGINE SPACES	INSIDE ENGINE SPACES	OUTSIDE OR INSIDE ENGINE SPACES
18	4.0	2.3	4.0	3.0	6.0	4.7	8.0	6.6	8.0	6.8	10.0	8.9	10.0
16	6.0	3.5	6.0	4.5	8.0	6.2	10.0	8.2	10.0	8.5	12.0	10.7	14.0
14	8.0	4.6	8.0	6.0	10.0	7.8	12.0	9.8	14.0	11.9	16.0	14.2	18.0
12	10.0	5.8	10.0	7.5	14.0	10.9	16.0	13.1	18.0	15.3	20.0	17.8	22.0
10	16.0	9.3	16.0	12.0	20.0	15.6	22.0	18.0	24.0	20.4	28.0	24.9	28.0
8	22.0	12.8	26.0	19.5	28.0	21.8	28.0	23.0	32.0	27.2	36.0	32.0	40.0
6	32.0	18.6	38.0	28.5	40.0	31.2	40.0	32.8	48.0	40.8	50.0	44.5	54.0
4	42.0	24.4	50.0	37.5	52.0	40.6	54.0	44.3	64.0	54.4	68.0	60.5	72.0
3	48.0	27.8	58.0	43.5	60.0	46.8	62.0	50.8	72.0	61.2	78.0	69.4	84.0
2	56.0	32.5	68.0	51.0	70.0	54.6	72.0	59.0	84.0	71.4	90.0	80.1	96.0
1	66.0	38.3	78.0	58.5	84.0	65.5	84.0	68.9	98.0	83.3	106.0	94.3	112.0
0	78.0	45.2	92.0	69.0	98.0	76.4	98.0	80.4	114.0	96.9	122.0	108.6	130.0
00	90.0	52.2	106.0	79.5	114.0	88.9	114.0	93.5	132.0	112.2	142.0	126.4	148.0
000	104.0	60.3	124.0	93.0	132.0	103.0	132.0	108.2	154.0	130.9	164.0	146.0	172.0
0000	120.0	69.6	144.0	108.0	154.0	120.1	154.0	126.3	178.0	151.3	190.0	169.1	204.0

HOW TO SELECT A CONDUCTOR

(a) FACTORS

To select a conductor in accordance with the regulation there are a number of factors to consider:

(1) Temperature rating of conductor insulation.
(2) Current rating required for the circuit.
(3) Is the conductor in an engine space.
(4) Is the system voltage less than 50 volts or, 50 volts or more.
(5) How many conductors will be run in a bundle.
(6) What type of conductor is permitted; i.e. SAE, NEC, IEEE, UL or other.

(b) PROCEDURE

(1) Determine the Circuit Load – Add up the rated loads of the electrical devices in the circuit.

The boat manufacturer will have to determine the circuit loads in the boat in order to properly size conductors and the related overcurrent protection. If a conductor is supplying a single load, sizing the conductor and its overcurrent protection is simple. If, however, a single conductor is supplying multiple or cumulative loads such as a distribution panel, the boat manufacturer does not have to size the conductor to carry the summation of all the loads connected to the panel, but only a percentage of these loads due to loading factors. The regulation does not require that a conductor be sized to carry the full load of a distribution panel, but does require that proper overcurrent protection be provided for the size of conductor chosen.

Basically the boat manufacturer has a choice between the extremes of:

- providing a conductor that can carry the full load, or
- using a smaller conductor that is adequate because of load factors, but large enough to avoid nuisance tripping of its overcurrent protection.

Of course, whichever size conductor is used it must be protected with the proper size overcurrent protection. It must also be noted that 183.425(b) restricts the maximum load a conductor may carry to that specified in Table 5 except for intermittent higher currents as discussed on page 48. (See 183.455 and 183.460 for Overcurrent Protection Requirements)

(2) Decide what temperature rating of conductor will be used.

(3) If in an Engine Space – Apply the correction factor to the amperage values in Table 5 for the temperature rating selected. Tables 5A through 5E provide a column of corrected amperages for use in engine spaces.

(4) If the Electrical System is 50 Volts or More – Determine the number of current carrying conductors (grounding conductors are not normally current carrying) that will be bundled together. If more than 2, select the appropriate correction factor and apply it to the amperage values in Table 5 or as corrected for use in engine spaces. Tables 5B through 5E provide corrected amperages for various numbers of conductors in bundles and also provide a column for conductors used in engine spaces.

(5) In Table 5 (or Tables 5A through 5E) under the column for the selected temperature rating of conductor, find the amperage that, when the necessary correction factors are applied (not needed when using Tables 5A through 5E), equals or exceeds the circuit load.

(6) Read the gauge of the conductor to be used.

(7) Select a conductor of STRANDED COPPER construction with insulation properties permitted in accordance with the system voltage:

(a) Less Than 50 Volts – SAE conductors are permitted in addition to those for 50 volts and over. See 183.430, page 50.

(b) 50 Volts or More – NEC, IEEE, UL and specifically designated marine conductors are permitted. See 183.435, page 51.

(c) EXAMPLES

(1) A circuit in a boat consists only of a 12 volt bilge pump (rated at 12 amps). The bilge pump and its wiring are in the engine compartment and the conductors will run in a bundle of 8 conductors except where they break out of the bundle to go to the pump, a distance of 40 inches from the bundle.

FACTS – Circuit load – 12 amps
Location – Engine space
Bundling – 8 conductors
Voltage – Less than 50 volts

CONDUCTOR – This boat builder decides to use 75°C temperature rated conductors for the bilge pump.

ENGINE SPACE CORRECTION – The factor for 75°C conductors is 0.75.

CALCULATION – In Table 5, under 75°C a 16 AWG conductor will carry 15 amps, however when corrected for use in an engine space it may only carry:

0.75 x 15 = 11.25 amps
16 AWG, 75°C conductors are too small.

Try 14 AWG,
0.75 x 20 = 15 amps
14 AWG, 75°C conductors may be used.
(Tables 5A may be used in lieu of these calculations)

NOTE: Bundling corrections DO NOT APPLY to conductors used in circuits less than 50 volts.

(2) A lighting and receptacle circuit is planned for the 120 VAC system on a boat. The maximum permanent lighting load is known to be 5 amps. The receptacle load is unknown but the receptacles are rated at 15 amps. The conductors go through the engine space in a bundle of 8 conductors, 3 of which are DC and 5 of which are current carrying AC conductors.

FACTS – Circuit load – Unknown
Location – Conductors run through engine space.
Bundling – 8 conductors, 3 DC, 5 AC.
Voltage – 50 volts or over (120 VAC actual).

CONDUCTOR – The boat builder decides to use 75°C temperature rated conductors for this lighting and receptacle circuit.

ENGINE SPACE CORRECTION – The factor for 75°C conductors is 0.75. The correction factor applies to the length of conductors used in the engine space. The lengths outside the engine space need no correction. If a conductor runs inside and outside an engine space it must be sized for the engine space.

CIRCUIT LOAD – Since the circuit load is unknown, the size of the circuit protection device will determine the anticipated load. In this case 20 amps was selected.

CALCULATION – In Table 5, under 75°C a 12 AWG conductor will carry 25 amps. Corrected for engine spaces it may only carry:

0.75 x 25 = 18.75 amps
12 AWG, 75°C conductors are too small.

Try 10 AWG,
0.75 x 40 = 30 amps

Bundling Correction – Even though there are 8 conductors in the bundle, only 5 are current carrying in circuits of 50 volts or more. Therefore, the correction factor used is for bundles of 4-6 conductors or, 0.60, not for bundles of 7-24.

Try 10 AWG corrected for engine spaces,
0.60 x 30 = 18 amps
10 AWG, 75°C conductors are too small.

Try 8 AWG,

Correct for engine spaces:	0.75	x	65	= 48.75
Correct for bundling:	0.60	x	48.75	= 29.25

8 AWG, 75°C conductors may be used in the engine spaces. Please note that outside the engine spaces, 10 AWG conductors may be used as the following bundling calculation shows:

0.60 x 40 = 24 amps
Conductors with a higher insulation temperature rating could be used to reduce the size of the conductor..(Table 5C may be used in lieu of these calculations)

(3) For the same example used in (c)(2) above, there is another method for determining proper conductor size. Again, use a 20 ampere load and a 75°C rated conductor. This method avoids the iterative process used in examples (1) and (2). Simply divide the load, 20 amperes, by the correction factor for engine space, 0.75:

$$\text{CALCULATION} - \frac{20}{0.75} = 26.67 \text{ amps}$$

Now divide the 26.67 amperes by the correction factor for bundling, 0.60:

$$\text{CALCULATION} - \frac{26.67}{0.60} = 44.44 \text{ amps}$$

Enter the 75°C column of Table 5 and select the first conductor size whose "allowable amperage" exceeds 44.44 amperes. In this case a 10 AWG conductor is allowed to carry 40 amperes which is not enough. An 8 AWG conductor can carry 65 amperes. The selection will have to be an 8 AWG conductor or larger. If an 80°C rating is used, then a 10 AWG conductor would be adequate. (Table 5C may be used in lieu of these calculations.)

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IT'S THE LAW

183.440 SECONDARY CIRCUITS OF IGNITION SYSTEMS

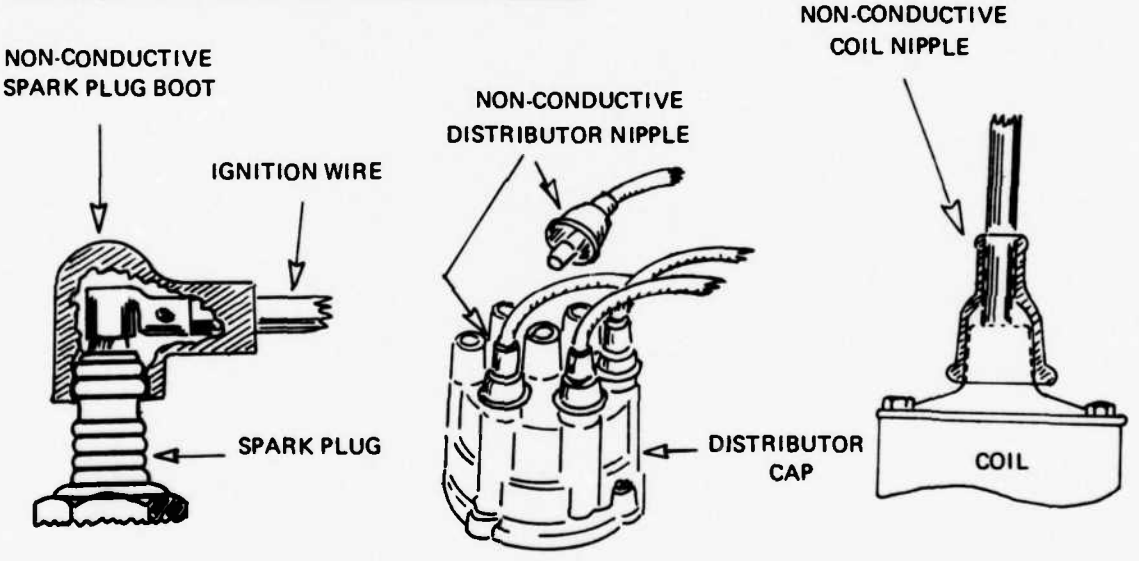
(a) Each conductor in a secondary circuit of an ignition system must meet SAE Standard J557, dated January 1968.

(b) The connection of each ignition conductor to a spark plug, coil, or distributor must have a tight fitting cap, boot, or nipple.

EFFECTIVE DATE: FEBRUARY 1, 1978

Conductors in the secondary circuits of ignition systems consist of the conductor from the center tap on the ignition coil to the center or rotor terminal on the distributor cap and the spark plug wires. These conductors must meet the specialized requirements of SAE Standard J557, "High Tension Ignition Cable". Both ends of these conductors must be connected in such a manner as to be protected by a tight-fitting cap, boot, or nipple. Caps, boots, or nipples that meet test requirements incorporated in SAE Standard J1191, "High Tension Ignition Cable Assemblies" are acceptable.

FIGURE 20 – IGNITION CONDUCTOR CONNECTIONS



DO YOU COMPLY

Each secondary circuit conductor meets the requirements of SAE J557. ( )

All connected ends of secondary circuit conductors are equipped with tight-fitting caps, boots, or nipples. ( )

IT'S THE LAW

183.445 CONDUCTORS: SUPPORT AND PROTECTION

(a) Except for the first 36 inches of a conductor leading from a battery terminal, each conductor must be supported by clamps or straps not more than 18 inches apart unless the conductor is supported by rigid ducts or conduits. The clamps, straps, ducts, or conduits must be designed to prevent chafing or damage to the conductor insulation.

EFFECTIVE DATE: AUGUST 1, 1977

Conductors must be supported. This may be by a rigid duct or conduit (See Figure 21). This may also be by clamps or straps, but they must be NO MORE THAN 18 INCHES apart (See Figure 22). No matter what type of support is used, it must not chafe or damage the conductor insulation. Supports for conductors, sheaths, conduits, ducts, etc. do not have to be fire resistant. When measuring the 18 INCHES MAXIMUM between supports, the measurement is taken in a straight line from support to support and not along the conductor. The 18 INCH MAXIMUM measurement applies to supports along the same conductor or conductors.

REGULATORY EXCEPTIONS 183.445(d) –
This section does not apply to communications systems; electronic navigation equipment; and high voltage secondary conductors and terminations in the ignition system.

FIGURE 21 – RIGID DUCT OR CONDUIT

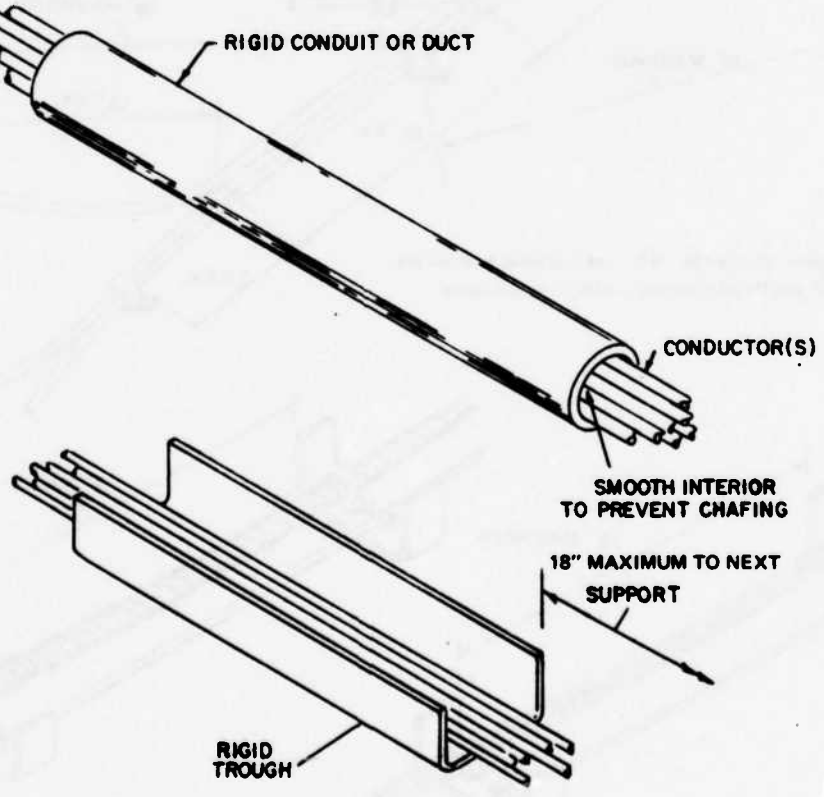
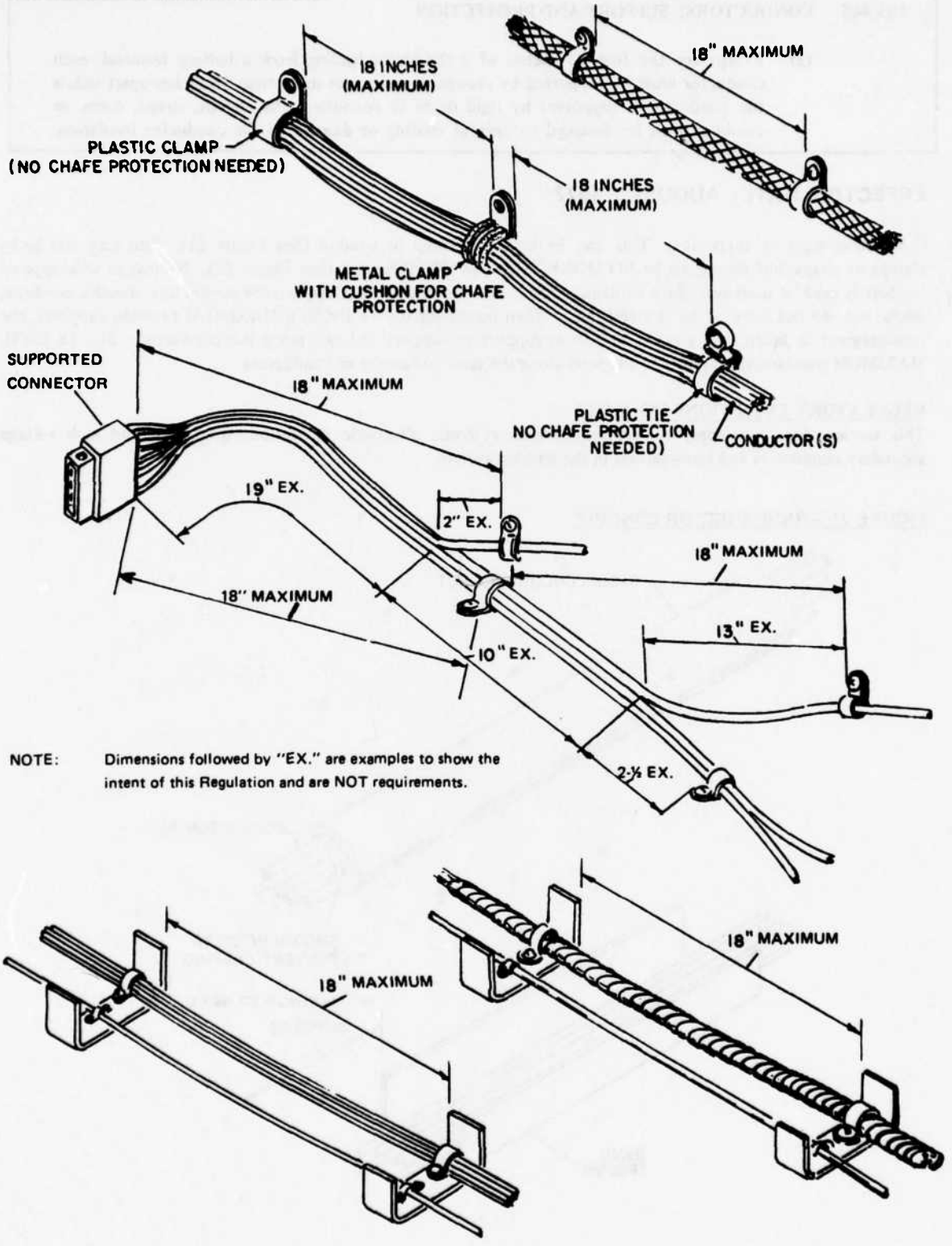
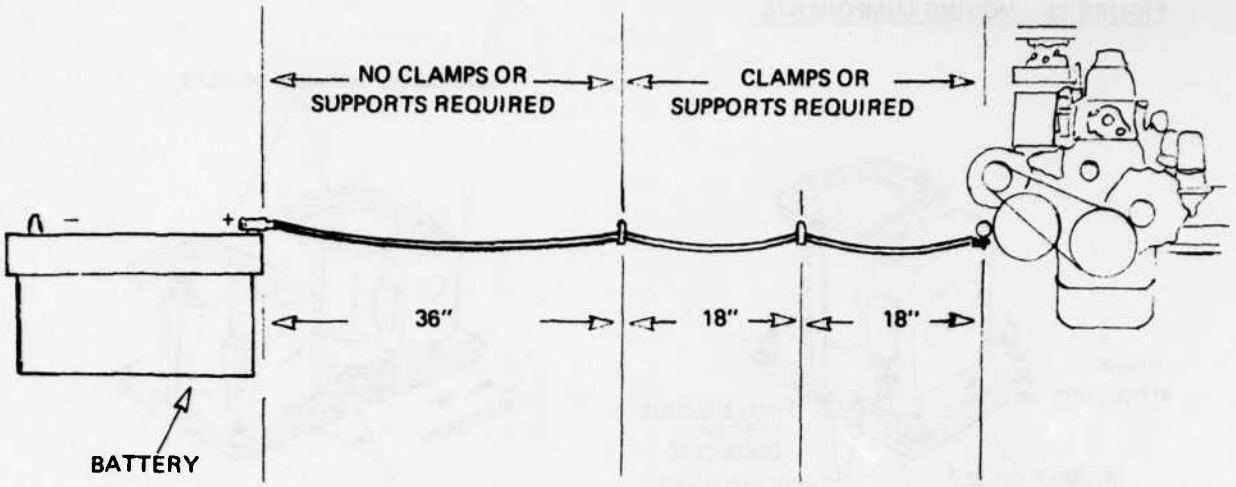


FIGURE 22 – CONDUCTOR SUPPORT



NOTE: Dimensions followed by "EX." are examples to show the intent of this Regulation and are NOT requirements.



BATTERY CABLE SUPPORT

DO YOU COMPLY

Is each conductor, except for the first 36 inches of a conductor leading from a battery, supported by:

- a conduit? and/or ( )
- a rigid duct? and/or ( )
- clamps 18 inches apart? and/or ( )
- straps 18 inches apart? ( )

Are the conductor supports designed to prevent chafing or damage to conductor insulation? ( )

IT'S THE LAW

183.445 CONDUCTORS: SUPPORT AND PROTECTION

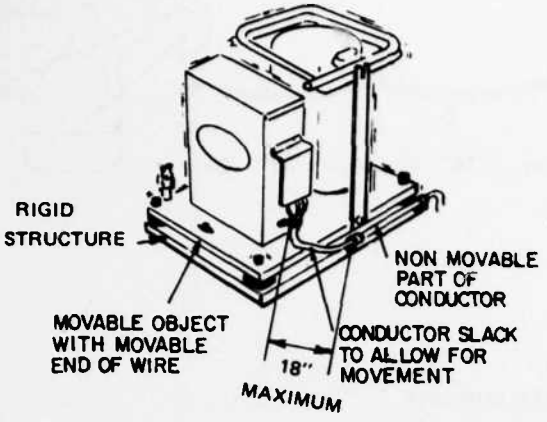
(b) If conductors or groups of conductors are connected between two components that can move in relation to each other, each conductor or group of conductors must have a loop, slack, or other strain relief.

EFFECTIVE DATE: AUGUST 1, 1977

A conductor must not be strained when one end of it moves and the remainder of it doesn't (See Figure 23a). This also applies to conductors between two different items, each of which may move separately from the other (See Figure 23b). This does not apply to conductors where the ENTIRE conductor is mounted on a single movable object (See Figure 23c).

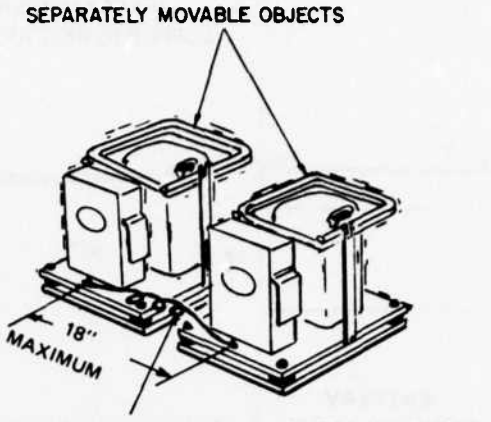
REGULATORY EXCEPTIONS 183.445(d) –
This section does not apply to communications systems; electronic navigation equipment; and high voltage secondary conductors and terminations in the ignition system.

FIGURE 23 – MOVING COMPONENTS



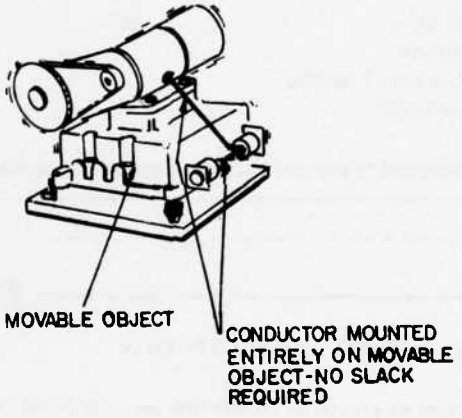
FIXED CONDUCTOR AND MOVABLE OBJECT

– a –



TWO MOVABLE OBJECTS

– b –



CONDUCTOR MOUNTED ENTIRELY ON MOVABLE OBJECT

– c –

DO YOU COMPLY

Is there a loop, slack, or other strain relief provided for conductors connected to two components that can move in relation to each other? ( )

183.445 CONDUCTORS: SUPPORT AND PROTECTION

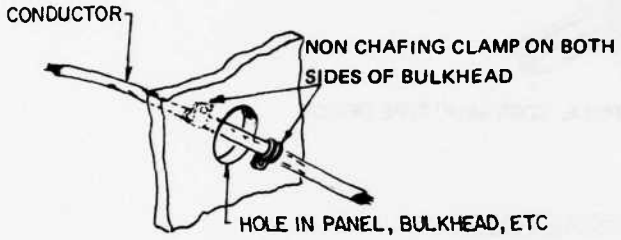
(c) Conductors that pass through a bulkhead, structural member, junction box, or other rigid surface must be protected from abrasion.

EFFECTIVE DATE: AUGUST 1, 1977

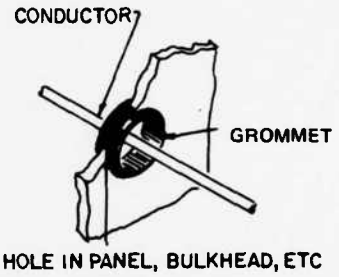
A conductor or bundle of conductors must have abrasion protection, in addition to its own insulation, where it goes through a hole. This applies to holes in any rigid surface such as bulkheads, junction boxes, electric panels, etc. Any means such as clamping (See Figure 24a), grommets (See Figure 24b), caulking (See Figure 24c), hose (See Figure 24d), bushings (See Figure 24e), taping (See Figure 24f), special devices (See Figure 24g), or others may be used. Note requirements for isolation bulkhead openings if applicable. (See 183.410(c) on page 24)

REGULATORY EXCEPTIONS 183.445(d) –
This section does not apply to communications systems; electronic navigation equipment; and high voltage secondary conductors and terminations in the ignition system.

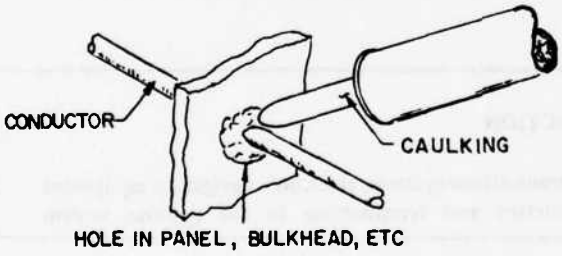
FIGURE 24 – ABRASION PROTECTION



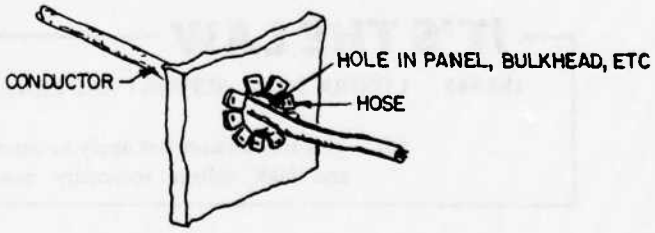
CLAMP
– a –



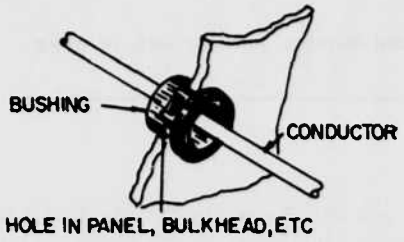
GROMMET
– b –



CAULKING
– c –

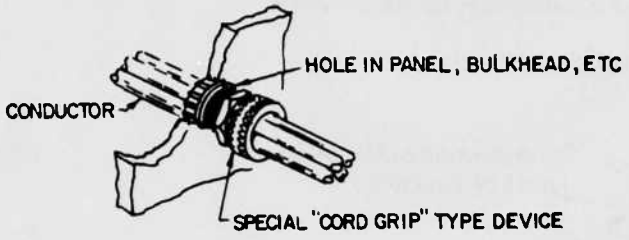


HOSE
– d –



BUSHING
– e –

TAPING
– f –



SPECIAL DEVICE
– g –

DO YOU COMPLY

Is there abrasion protection for conductors that pass through a bulkhead, structural member, junction box, or other rigid surfaces? ( )

IT'S THE LAW

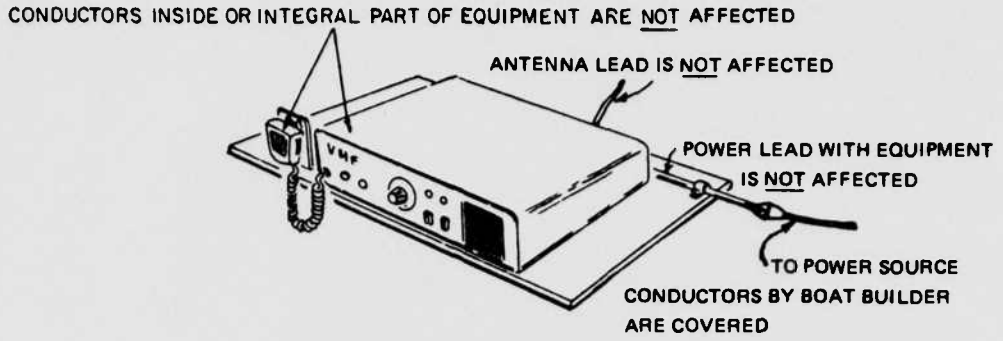
183.445 CONDUCTORS: SUPPORT AND PROTECTION

(d) This section does not apply to communications systems, electronic navigation equipment; and high voltage secondary conductors and terminations in the ignition system.

EFFECTIVE DATE: AUGUST 1, 1977

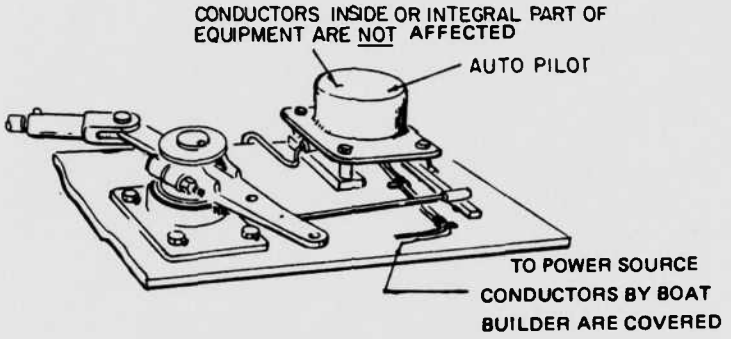
Conductors in some applications are not affected by (or do not have to meet these requirements) this requirement for support and protection. It does not apply to wiring for communications systems (See Figure 25a), electronic navigation equipment (See Figure 25b), or ignition system secondaries (See Figure 25c). Power source conductors that are part of the above equipment are not covered. Power source conductors supplied by the boat builder are covered. Antenna conductors are not covered.

FIGURE 25 – EXCEPTIONS TO SUPPORT AND PROTECTION REQUIREMENTS



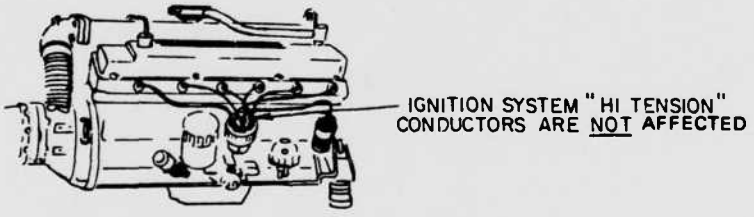
COMMUNICATION EQUIPMENT

– a –



ELECTRONIC NAVIGATION EQUIPMENT

– b –



IGNITION SYSTEM SECONDARIES

– c –

DO YOU COMPLY

NOTE PERMITTED EXCEPTIONS FOR:

- communications systems
- electronic navigation equipment
- ignition system

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(a) Each connection to a screw terminal or stud that is outside of a junction box or enclosure must be connected by a closed ring connector, eyelet connector, captive spade connector, mechanical locking connector, or spring locking connector.

EFFECTIVE DATE: FEBRUARY 1, 1978

The listed connectors in the regulation are usually known as "terminals" in the industry and connections are likewise known as "terminations". For the following discussion the terms usually known to industry are used.

Unless a termination to a SCREW OR STUD is made inside a junction box or enclosure, only certain types of terminals may be used. This is to prevent damage to the strands of the conductor and ensure a good connection. The only allowable types are of the mechanical locking variety such as closed ring (See Figure 26a), eyelet (See Figure 26b), captive spade (See Figure 26c), or spring locking (See Figure 26d).

Terminations inside junction boxes or enclosures may be accomplished by other means. Junction boxes or enclosures recognized by the National Electrical Code are acceptable. The National Electrical Code defines "enclosure" as follows:

> "Enclosure – The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts, or to protect the equipment from physical damage."

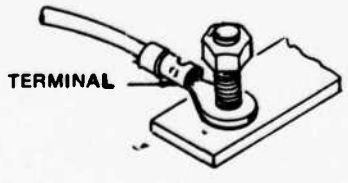
A junction box is defined by IEEE as follows:

> "Junction Box – A box with a blank cover that serves the purpose of joining different runs of raceway or cable and provides space for the connection and branching of the enclosed conductors.
>
> An enclosed distribution panel for connecting or branching one or more corresponding electric circuits without the use of permanent splices."

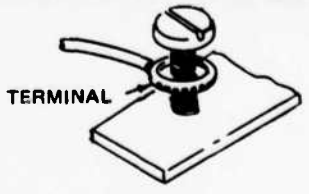
For the purpose of this regulation the US Coast Guard will make the final determination of what qualifies as an enclosure or junction box, however, appliances, switch boxes, receptacle boxes, enclosed panelboards, enclosed switchboards, enclosed instrument panels and utility boxes are all considered junction boxes or enclosures.

REGULATORY EXCEPTIONS 183.450(i) –
This section does not apply to communication systems and electronic navigation equipment.

FIGURE 26 – TERMINATIONS FOR CONDUCTORS – MECHANICAL LOCKING

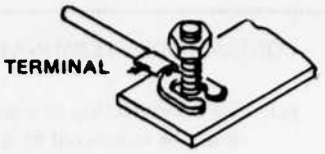


CLOSED RING
– a –



EYELET
– b –

CAPTIVE SPADE
– c –



SPRING LOCKING
– d –

DO YOU COMPLY

Is each termination to a screw terminal or stud made by:

- a mechanical locking terminal such as, ( )
- a closed ring terminal? or ( )
- an eyelet terminal? or ( )
- a captive spade terminal? or ( )
- a spring locking terminal? ( )

NOTE EXCEPTION:

TERMINATIONS INSIDE A JUNCTION BOX OR ENCLOSURE

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

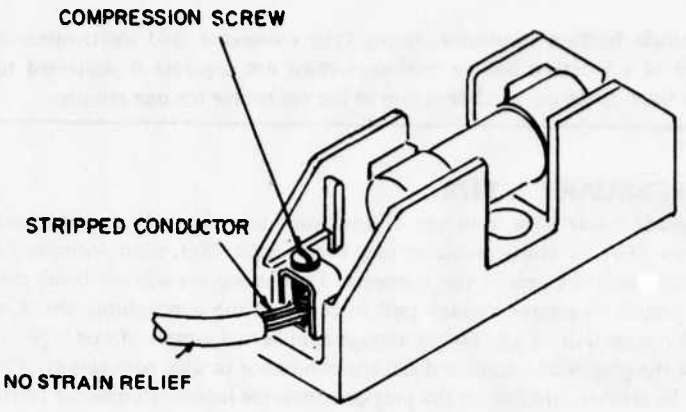
(b) Each stripped conductor connected to a compression screw terminal that is outside a junction box or enclosure must be secured mechanically to provide strain relief for the stripped conductor connection.

EFFECTIVE DATE: FEBRUARY 1, 1978

Unless the connection is made inside a junction box or enclosure, a compression screw terminal (See Figure 27a) cannot be used unless a strain relief means for the conductor is also provided (See Figure 27b). A compression screw terminal is one in which a follower, clamp or the end of the screw contacts the conductor's strands. A screw head impinging on the strands is NOT a compression type and is not permitted. (See 183.450(a) on page 73) **Refer** to page 73 for a discussion of junction boxes and enclosures.

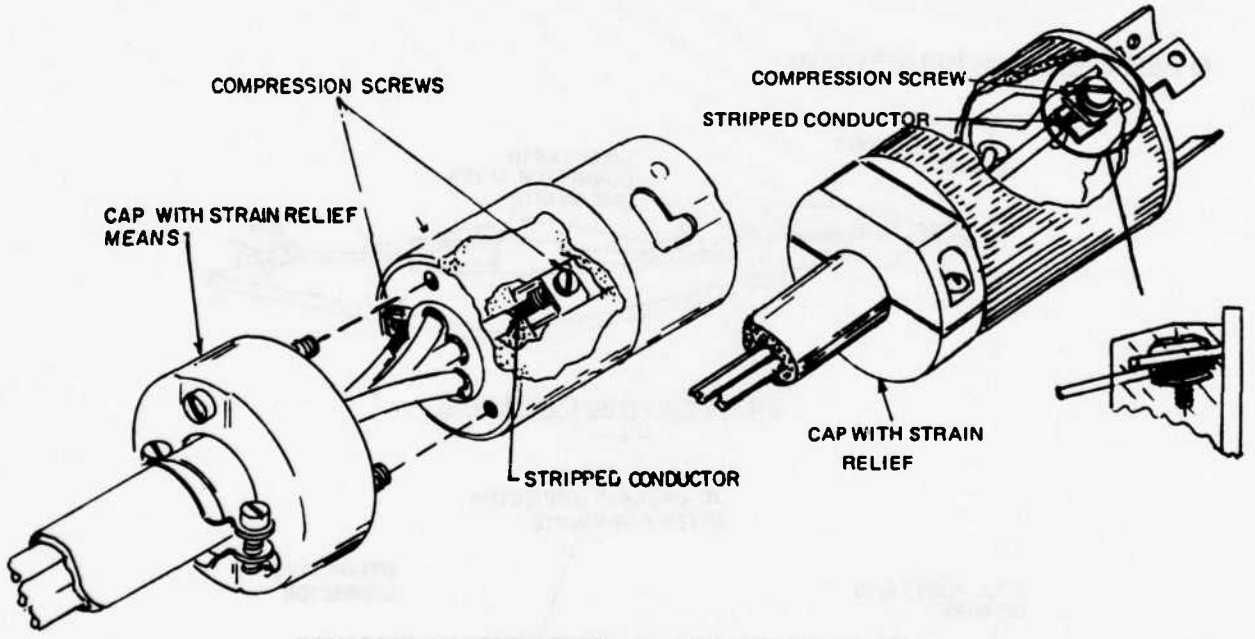
REGULATORY EXCEPTIONS 183.450(i) –
This section does not apply to communication systems and electronic navigation equipment.

FIGURE 27 – COMPRESSION SCREW TERMINATION



COMPRESSION SCREW TERMINAL BUT NO STRAIN RELIEF NOT ALLOWED

– a –



COMPRESSION SCREW TERMINAL WITH STRAIN RELIEF ALLOWED

– b –

DO YOU COMPLY

Is each stripped conductor connected to a compression screw terminal provided with strain relief? ( )

NOTE EXCEPTION:

TERMINATIONS INSIDE A JUNCTION BOX OR ENCLOSURE

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(c) Each single friction connector, spring type connector, and multiconnector plug that is outside of a junction box or enclosure must not separate if subjected to a six pound tensile force along the axial direction of the connector for one minute.

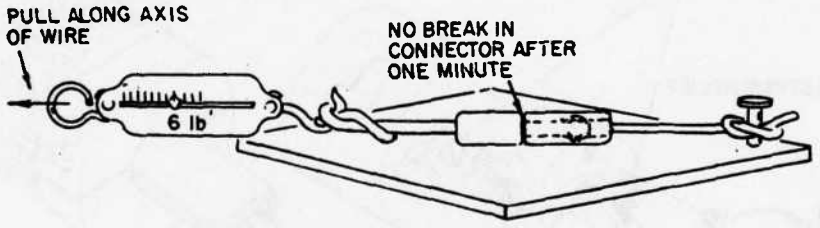
EFFECTIVE DATE: FEBRUARY 1, 1978

Unless the connection is made inside a junction box or enclosure, a single friction connector (See Figure 28a), spring-type connector (See Figure 28b), or multiconductor plug (See Figure 28c), must withstand a pull test. This test requires that a six pound pull along the axis of the connector for one minute will not break the connection. The actual testing will accept a six pound or greater average pull force of all the connections tested, with a minimum of four pounds for any individual connection. Each testing average applies to a sample of one type of connection. This test is to evaluate the strength of the plug connections and not the conductor to plug connection. Therefore, if the conductor pulls out, the test should be repeated pulling on the plug or connector halves. Connector retainers if used, should be in place during the test.

REGULATORY EXCEPTIONS 183.450(i) –

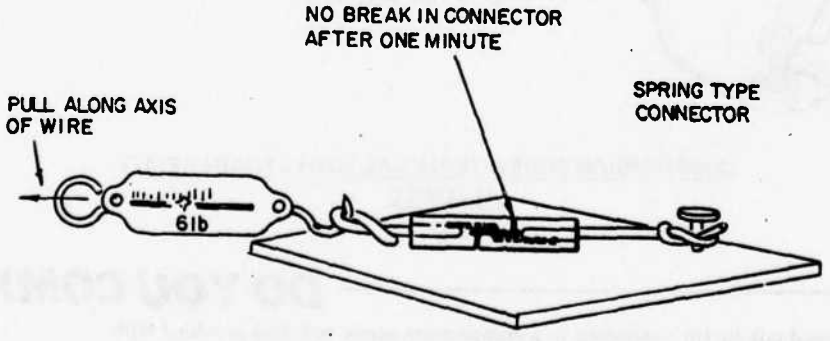
This section does not apply to communication systems and electronic navigation equipment.

FIGURE 28 – CONNECTOR STRENGTH



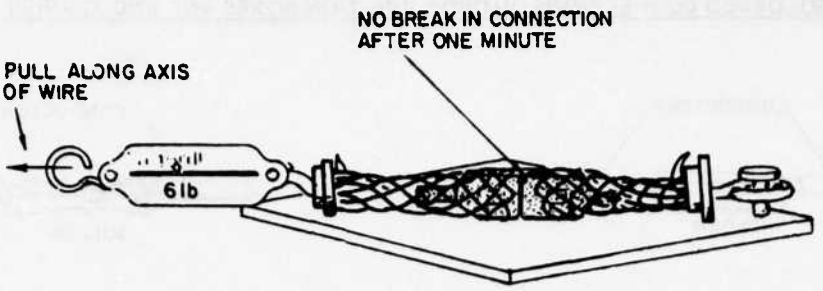
SINGLE FRICTION CONNECTOR

– a –



SPRING TYPE CONNECTOR

– b –



MULTICONDUCTOR PLUG

– c –

DO YOU COMPLY

Is each:

- single friction connector, and
- spring-type connector, and
- multiconnector plug capable of withstanding an axial six pound force for one minute? ( )

NOTE FXCEPTION:

TERMINATIONS INSIDE A JUNCTION BOX OR ENCLOSURE

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(d) A soldered connection that is outside a junction box or enclosure must not be the sole means of connection between two or more conductors or between a conductor and a connector, except a conductor may be soldered to a connector that joins the conductor to a battery terminal or stud, if the length of the soldered joint is at least 1.5 times the diameter of the stranded portion of the battery conductor.

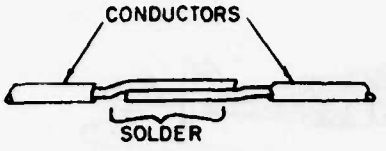
EFFECTIVE DATE: FEBRUARY 1, 1978

Solder must not be used as the only means of making a connection, however, soldered connections are acceptable if an additional mechanical means of connection is used such as twisting, crimping, etc. This applies to both conductor-to-conductor (See Figure 29a) and conductor-to-terminal (See Figure 29b) connections. (See discussion of US Coast Guard vs industry terminology on page 73). The only exception to this is that battery lugs may be soldered if the length of the solder joint is at least 1.5 times as long as the diameter of the conductor (See Figure 29c). Conductors connected to terminal strips must be mechanically connected to the terminal before soldering (See Figure 29d).

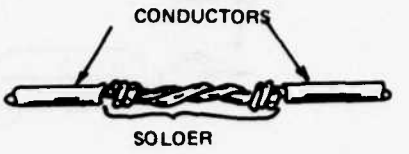
REGULATORY EXCEPTIONS 183.450(i) –

This section does not apply to communication systems and electronic navigation equipment.

FIGURE 29 – SOLDERED CONNECTIONS OUTSIDE JUNCTION BOXES AND ENCLOSURES

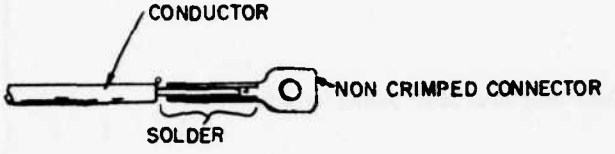


CONDUCTOR TO CONDUCTOR
NOT ALLOWED

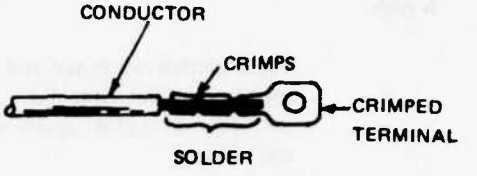


CONDUCTOR TO CONDUCTOR
PERMITTED IF TWISTED

– a –

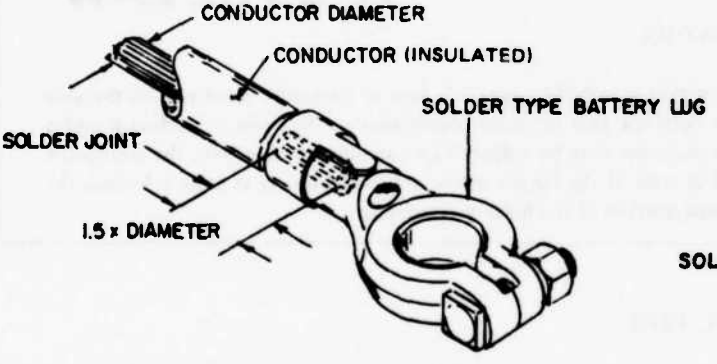


CONDUCTOR TO TERMINAL
NOT ALLOWED



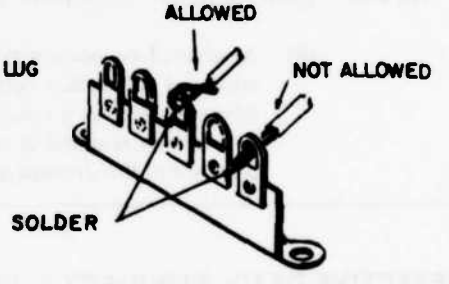
CONDUCTOR TO TERMINAL
PERMITTED IF CRIMPED

– b –



BATTERY TERMINAL CONNECTOR
ALLOWED

– c –



TERMINAL STRIP

– d –

DO YOU COMPLY

Are soldered connections provided with other means of connection when used between:

- two or more conductors, or ( )
- a conductor and a connector ? ( )

Are soldered connections, that join a conductor to a battery terminal or stud, a length of at least 1.5 times the diameter of the stranded portion of the conductor? ( )

NOTE EXCEPTION:

TERMINATIONS INSIDE A JUNCTION BOX OR ENCLOSURE

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(e) Each connection that is outside of a junction box or enclosure and that is used to join conductors to each other or that is used to join a conductor to a connector must not break when subjected for one minute to a tensile force shown in Table 6 for the smallest conductor size in the connection.

TABLE 6

TENSILE TEST VALUES FOR CONDUCTOR SPLICES
(conductor-conductor and conductor-connector joints)

WIRE SIZE (AWG)	TENSILE FORCE POUNDS	WIRE SIZE (AWG)	TENSILE FORCE POUNDS
18	10	4	70
16	15	3	80
14	30	2	90
12	35	1	100
10	40	0	125
8	45	00	150
6	50	000	175
5	60	0000	225

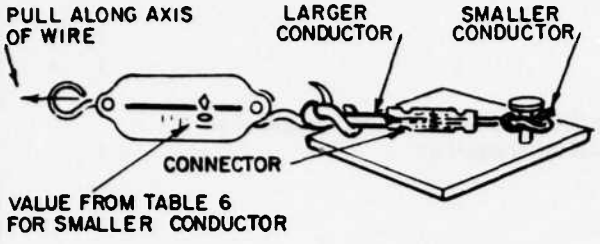
EFFECTIVE DATE: FEBRUARY 1, 1978

"Permanent" connections made outside of a junction box or enclosure must withstand a more severe test than that for "plug in" type connections as required in 183.450(c). The smallest conductor in a "permanent" connection must withstand the pull specified in Table 6 for one minute without breaking the connection. This applies to both conductor-to-conductor connections (See Figure 30a) or conductor-to-terminal connections (See Figures 30b and 30c). If there are 3 or more conductors connected in the same termination then each conductor connection shall be tested (See Figure 30d). (See discussion of US Coast Guard vs industry terminology on page 73).

REGULATORY EXCEPTIONS 183.450(i) –

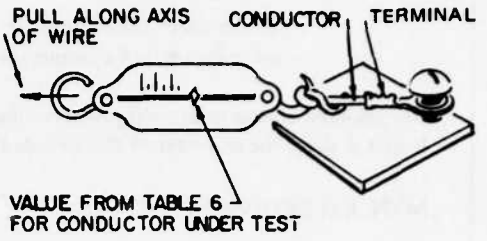
This section does not apply to communication systems and electronic navigation equipment.

FIGURE 30 – CONDUCTOR PULL OUT STRENGTH



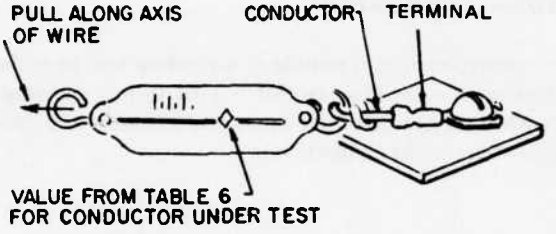
CONDUCTOR TO CONDUCTOR

– a –



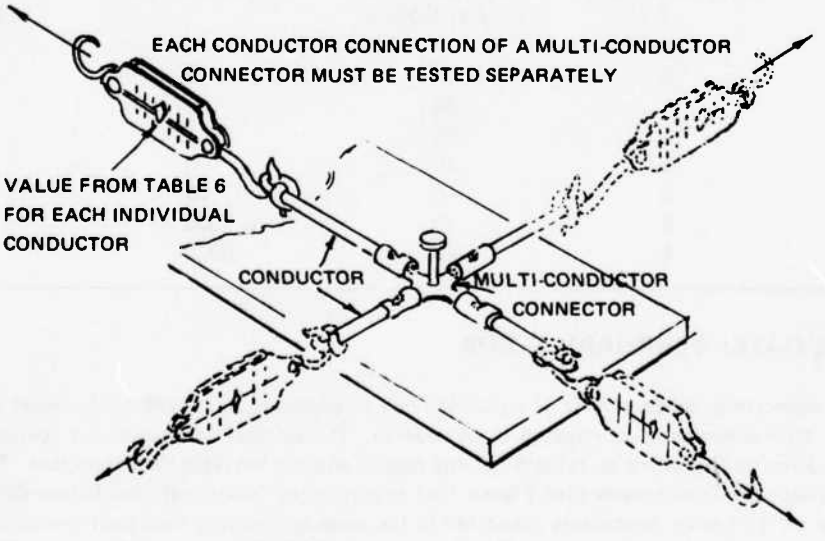
CONDUCTOR TO TERMINAL

– b –



CONDUCTOR TO TERMINAL

– c –



MULTI-CONDUCTOR CONNECTOR

– d –

DO YOU COMPLY

Are connections that are used to join:

- conductors to each other, or
- a conductor to a terminal capable of withstanding for one minute the force specified in Table 6 for the smallest conductor in the connection? ( )

NOTE EXCEPTION:

TERMINATIONS INSIDE A JUNCTION BOX OR ENCLOSURE

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(f) Each ungrounded terminal or stud that is continously energized must meet 183.455 or must have an insulated boot, nipple, cap, cover, or shield that prevents accidental short-circuiting at the terminals or studs.

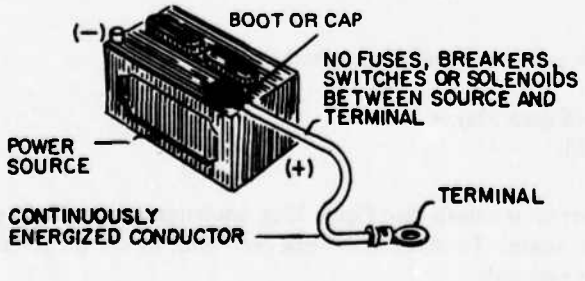
EFFECTIVE DATE: FEBRUARY 1, 1978

Any continuously energized terminal or stud that is not protected by a fuse or circuit breaker (per paragraph 183.455) must be protected from accidental short circuiting. Continuously energized means directly connected to a power source without any switches or solenoids between the source and the terminal (See Figure 31a). Protection against accidental short circuiting must be by an insulated boot, nipple, or cap (See Figure 31b) or cover (See Figure 31c) or shield (See Figure 31d). The test to determine if the protection is effective is whether or not the terminal or stud can be touched by 3/4 inches diameter ball (See Figures 31c and d). If it cannot be touched then the protection is adequate.

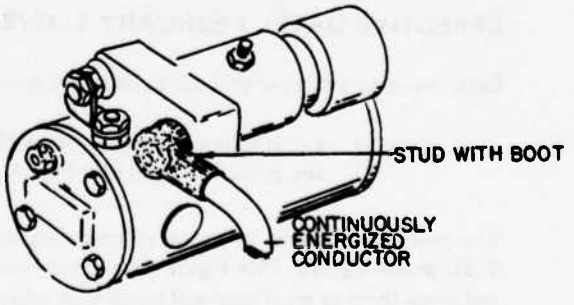
REGULATORY EXCEPTIONS 183.450(i) –

This section does not apply to communication systems and electronic navigation equipment.

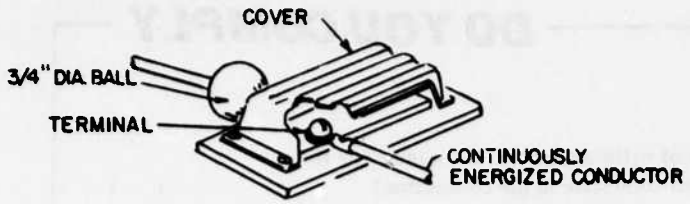
FIGURE 31 – TERMINAL PROTECTION



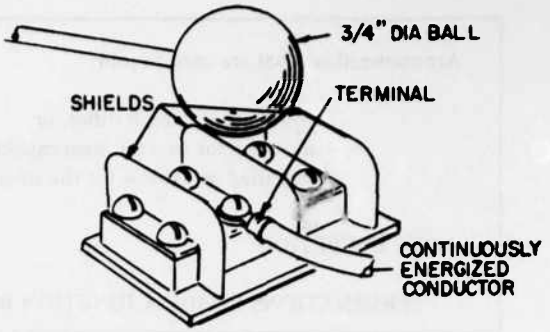
CONTINUOUSLY ENERGIZED TERMINAL
– a –



INSULATED BOOT, NIPPLE OR CAP
– b –



INSULATED COVER
– c –



SHIELD
– d –

DO YOU COMPLY

Is each continously energized ungrounded terminal or stud protected by:

– overcurrent protection (See 183.455)? or ( )
– an insulated boot, nipple, cap, cover or shield? ( )

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(g) Each termination composed of an ungrounded current-carrying-conductor, terminal fitting, and connector must be protected from accidental short-circuiting with –

(1) another termination from another circuit composed of an ungrounded current-carrying-conductor, terminal fitting, and connector; or

(2) any metal that is grounded.

EFFECTIVE DATE: FEBRUARY 1, 1978

Each connection of an ungrounded conductor must be protected from shorting with:

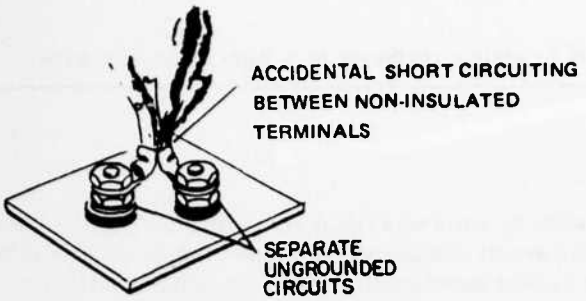
(1) a connection of another circuit (See Figure 32a) or,
(2) any grounded metal (See Figure 32b).

This protection may be by means of insulating sleeves on terminals (See Figure 32c), insulating barriers (See Figure 32d), insulating caps (See Figure 32e), or any other means. To check if shorting can occur, loosen the terminals and move them to see if they will touch each other or a ground.

REGULATORY EXCEPTIONS 183.450(i) –

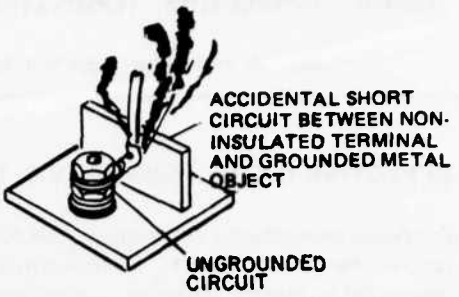
This section does not apply to communication systems and electronic navigation equipment.

FIGURE 32 – TERMINAL SHORT CIRCUITING



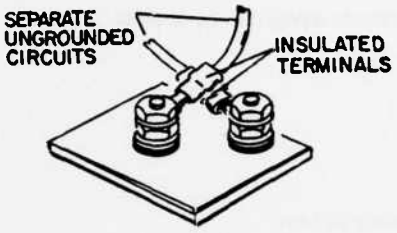
NO PROTECTION FROM SHORTING TO ANOTHER CIRCUIT–NOT ALLOWED

– a –



NO PROTECTION FROM SHORTING TO GROUNDED METAL – NOT ALLOWED

– b –

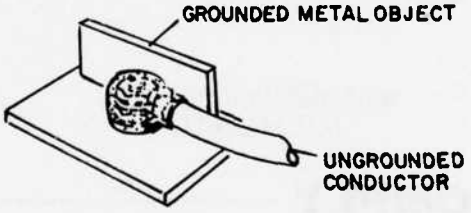


TERMINALS WITH INSULATING SLEEVES – ALLOWED

– c –

INSULATED BARRIERS – ALLOWED

– d –



INSULATED CAP – ALLOWED

– e –

DO YOU COMPLY

Is there protection against short-circuiting of ungrounded terminations with:

- ungrounded terminations of another circuit? or ( )
- a ground? ( )

IT'S THE LAW

183.450 CONDUCTORS: TERMINATION

(h) A conductor must not be joined to another conductor by a wire nut or wire screw.

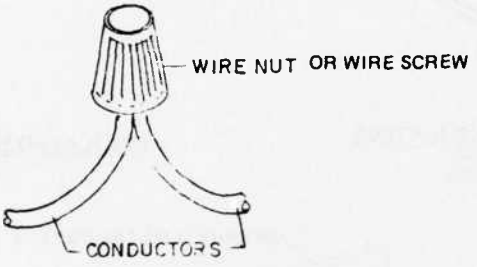
EFFECTIVE DATE: FEBRUARY 1, 1978

Conductor-to-conductor connections must NOT be made by use of wire nuts or wire screws (See Figure 33) even in junction boxes or enclosures. Internal wiring supplied as part of equipment or appliances does not have to be re-terminated to comply. However, connections made by boat manufacturers inside a junction box or enclosure may NOT be made with wire nuts or screws even if other connections in the junction box or enclosure are made with wire nuts or screws. This may be encountered when connecting power supply conductors to appliances, lighting fixtures, etc.

REGULATORY EXCEPTIONS 183.450(i) –

This section does not apply to communication systems and electronic navigation equipment.

FIGURE 33 – WIRE NUT OR WIRE SCREW PROHIBITION



WIRE NUT OR WIRE SCREW
NOT ALLOWED

DO YOU COMPLY

Are conductors joined by means OTHER THAN wire nuts or screws? ( )

IT'S THE LAW

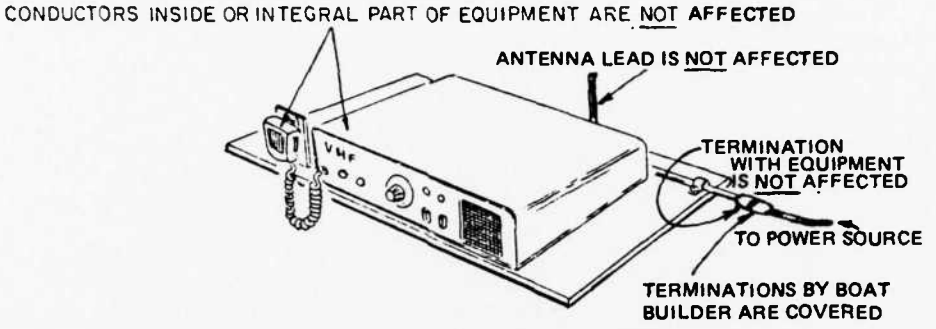
183.450 CONDUCTORS: TERMINATION

(i) This section does not apply to communication systems and electronic navigation equipment.

Conductors in some applications are not included in this requirement for termination. It does not apply to wiring for communications systems (See Figure 34a) or electronic navigation equipment (See Figure 34b). Power source conductors that are part of the above equipment are not covered. Power source conductors supplied by the boat builder are covered. Antenna conductors are not covered. Connections made by the boat builder must comply with the termination requirements of this regulation.

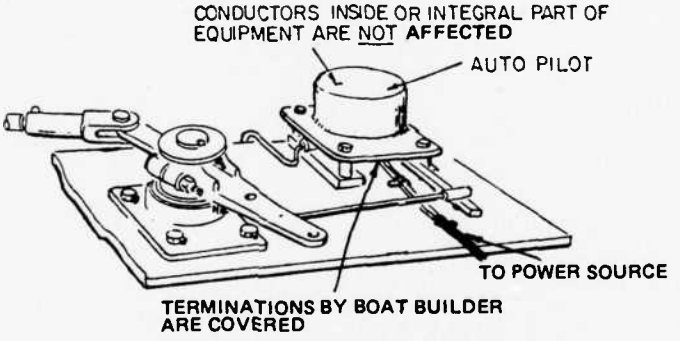
NOTE: Navigation lights are NOT electronic navigation equipment.

FIGURE 34 – TERMINATION EXCEPTIONS



COMMUNICATION EQUIPMENT

– a –



ELECTRONIC NAVIGATION EQUIPMENT

– b –

DO YOU COMPLY

NOTE PERMITTED EXCEPTIONS FOR:

- **communications systems, and**
- **electronic navigation equipment.**

IT'S THE LAW

183.455 OVERCURRENT PROTECTION: GENERAL

(a) Each ungrounded current-carrying-conductor must be protected by a manually reset, tripfree circuit breaker or fuse.

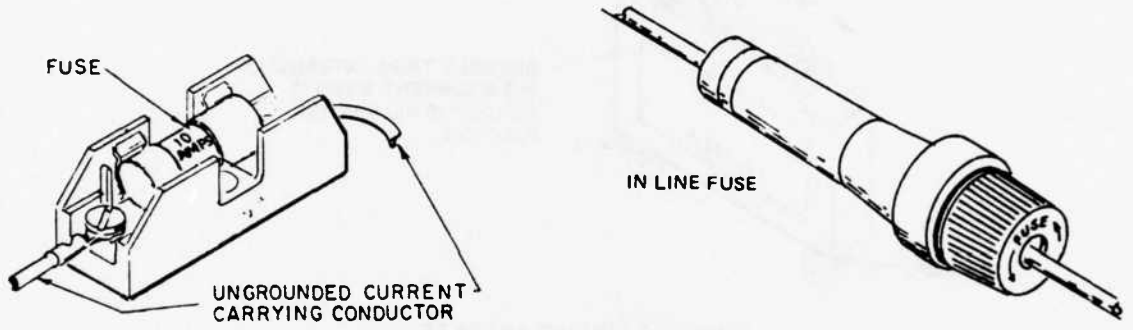
EFFECTIVE DATE: FEBRUARY 1, 1978

Each ungrounded conductor used to carry current must be protected by a fuse (See Figure 35a) or a circuit breaker (See Figure 35b). If used, a circuit breaker must be of the manually reset type (See Figure 35c) rather than the automatic reset type (See Figure 35d). Additionally, the circuit breaker must be of the tripfree type – this means that the breaker will open the circuit even if the handle is held in the "on" position (See Figure 35e).

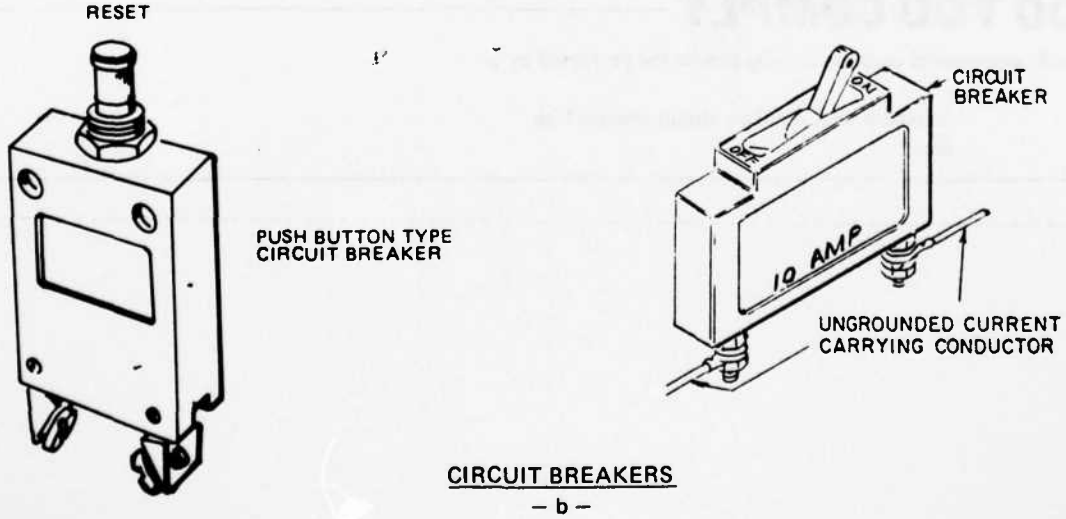
REGULATORY EXCEPTIONS 183.455(e) –

This section does not apply to resistance conductors that control circuit amperage or voltage; pigtails of less than seven inches of exposed length; conductors in secondary circuits of ignition systems; and power supply conductors in cranking motor circuits.

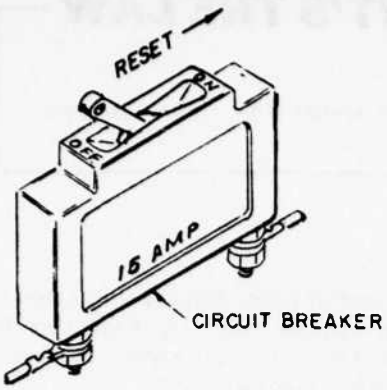
FIGURE 35 – OVERCURRENT PROTECTION



FUSES
–a–

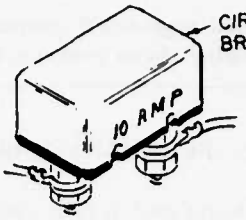


CIRCUIT BREAKERS
– b –



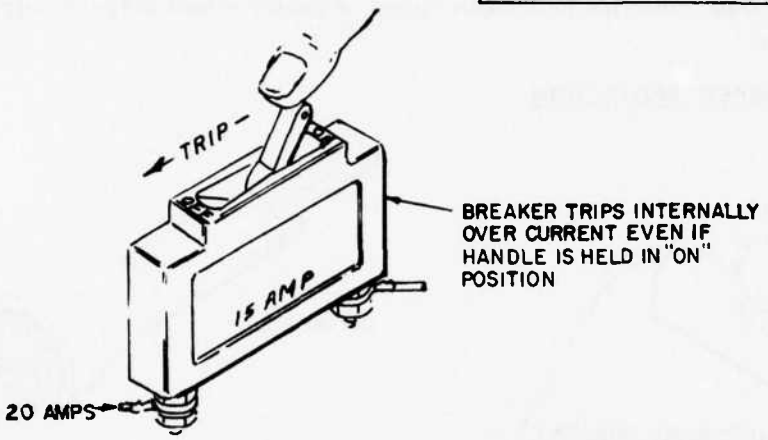
MANUALLY RESET

– c –



AUTOMATIC CIRCUIT BREAKER NOT ALLOWED

– d –



TRIP FREE CIRCUIT BREAKER

– e –

DO YOU COMPLY

Is each ungrounded current-carrying-conductor protected by a:

– manually reset, tripfree circuit breaker? or ( )
– fuse? ( )

183.455 OVERCURRENT PROTECTION: GENERAL

(b) A manually reset, tripfree circuit breaker or fuse must be –

(1) at the source of power for each conductor;

(2) at the point where the conductor size is reduced to a smaller gauge; or

(3) at the origin of a circuit, if the circuit breaker or fuse has a current rating that prevents overloading of the smallest conductor in the circuit.

EFFECTIVE DATE: FEBRUARY 1, 1978

The circuit breaker or fuse required in 183.455(a) must be located in one of the three places:

(1) at the point where a conductor receives its power (See Figure 36a),
(2) at the point where a smaller conductor is connected to a larger conductor (See Figure 36b), or
(3) at the point where a circuit initially receives its power if the breaker or fuse is sized to protect the smallest conductor in the circuit (See Figures 36c and d).

The schematic shows these methods of overcurrent protection (See Figure 36e).

Locations (1) and (2) actually describe a single location. The point in a circuit where a smaller conductor is connected to a larger conductor becomes the source of power for the smaller conductor. Basically each conductor, noting the permitted exceptions, must be provided with overcurrent protection. This overcurrent protection may be located at a conductor's power source or at the point where the circuit receives its power as long as the current rating of the overcurrent protection device protects the smaller conductor. Circuits in which there is no reduction in conductor size must be protected at the circuit's source of power again noting the permitted exceptions.

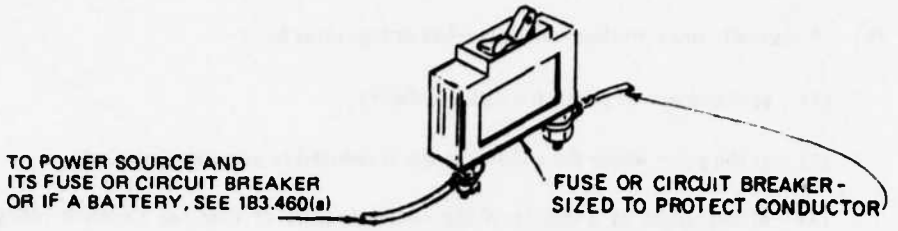
For shore power installations the source of power is the dockside or shore located receptacle. The shore power cable and the main power feeders from the shore power inlet on the boat to the main distribution panel are protected by overcurrent protection at the dockside or shore located connection.

Circuits using conductors of different insulation temperature ratings resulting in the use of a smaller gauge conductor to carry the same or larger rated current must have overcurrent protection sized to protect the conductor with the lowest amperage rating. For example, if a 10 AWG supply conductor (60°C) is connected to a 14 AWG conductor (125°C), the conductor amperage capacity is 40 amps in both cases and therefore one circuit breaker at the source end of the 10 AWG conductor is all that is needed.

REGULATORY EXCEPTIONS 183.455(e) –

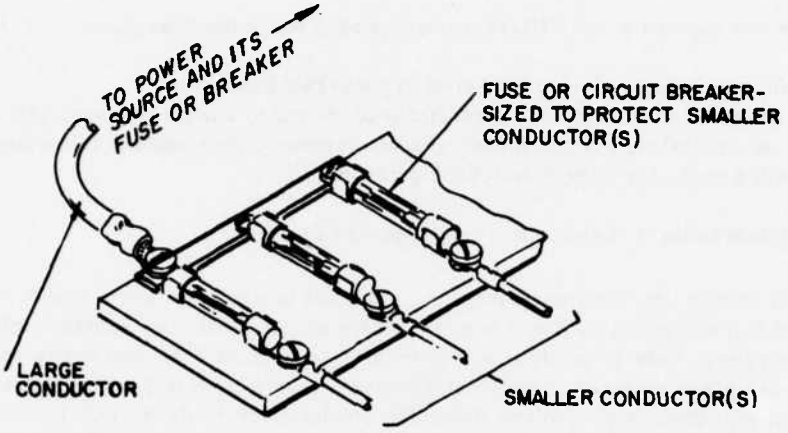
This section does not apply to resistance conductors that control circuit amperage or voltage; pigtails of less than seven inches of exposed length; conductors in secondary circuits of ignition systems; and power supply conductors in cranking motor circuits.

FIGURE 36 – LOCATION OF OVERCURRENT PROTECTION



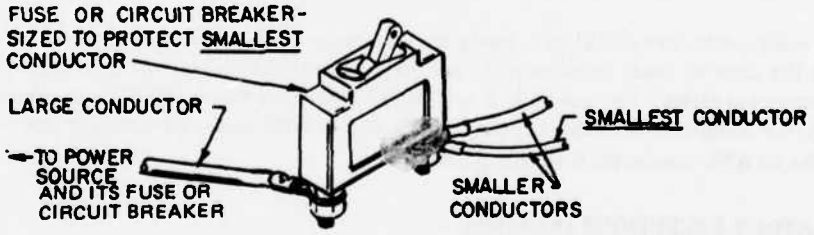
AT POWER SOURCE

– a –



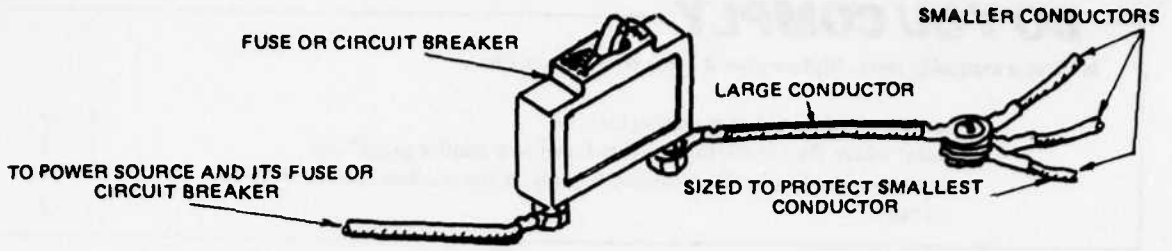
AT POINT OF CONDUCTOR SIZE REDUCTION

– b –



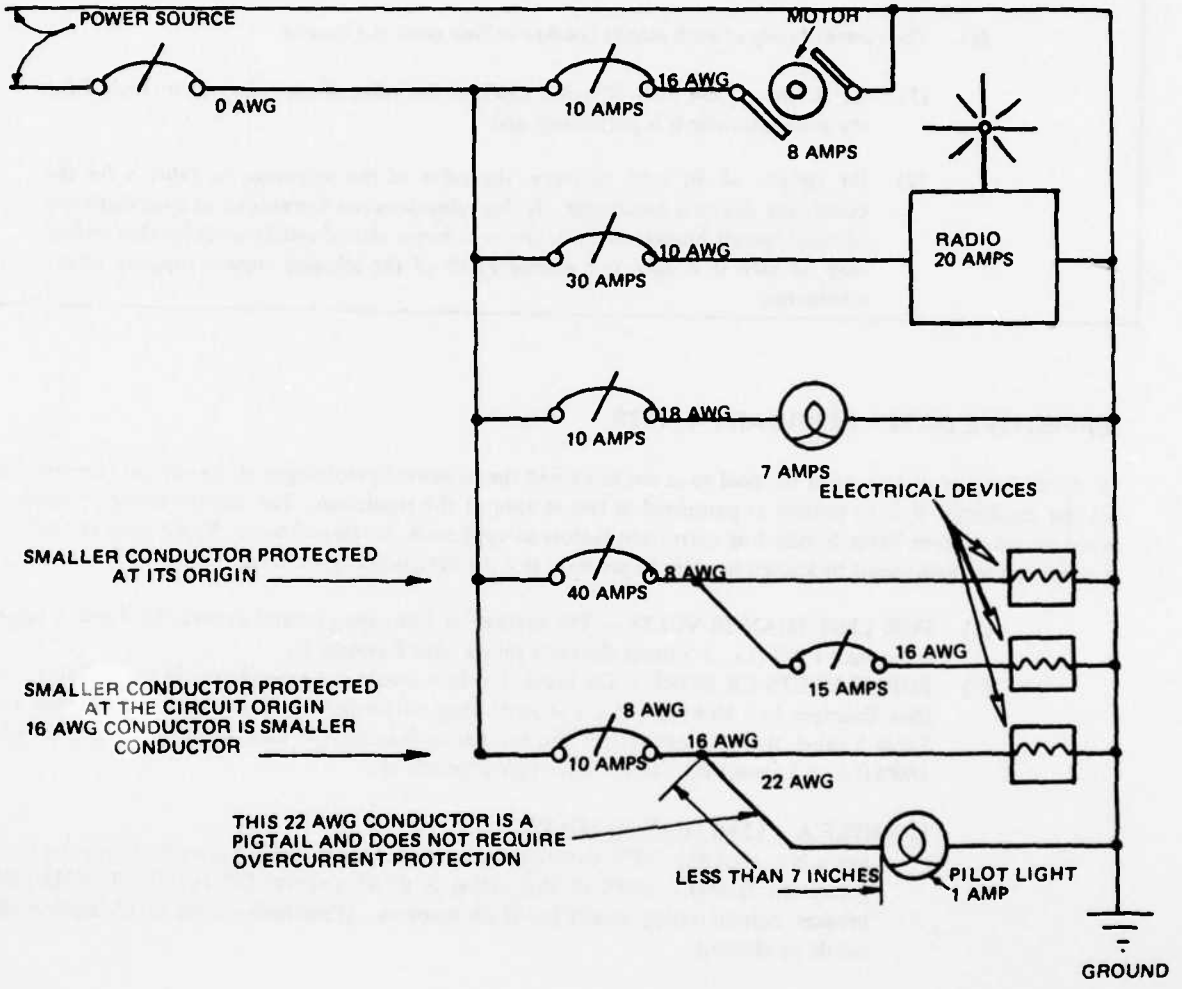
AT POWER SOURCE–SIZED TO PROTECT SMALLEST CONDUCTOR

– c –



AT POWER SOURCE SIZED TO PROTECT SMALLEST CONDUCTOR

-- d --



-- e --

DO YOU COMPLY

Is there a manually reset, tripfree circuit breaker or fuse at the:

- source of power for each conductor? or ( )
- point where the conductor size is reduced to a smaller gauge? or ( )
- at the origin of a circuit, providing it protects the smallest conductor in the circuit? ( )

IT'S THE LAW

183.455 OVERCURRENT PROTECTION: GENERAL

(c) The current rating of each circuit breaker or fuse must not exceed –

(1) for circuits of less than 50 volts, 150% of the value of the amperage in Table 5 for the conductor size it is protecting; and

(2) for circuits of 50 volts or more, the value of the amperage in Table 5 for the conductor size it is protecting. If this value does not correspond to a standard size of rated circuit breaker or fuse, the next larger size of rated circuit breaker or fuse may be used if it does not exceed 150% of the allowed current capacity of the conductor.

EFFECTIVE DATE: FEBRUARY 1, 1978

A circuit breaker or fuse must be sized so as not to exceed the permitted percentages of the current (ampere) rating of the conductor it is to protect as permitted in this section of the regulation. The current rating of conductors must be taken from Table 5 including correction factors as applicable, as referred to in 183.425 and 183.435. The voltage of the circuit must be known in order to properly size the overcurrent protection.

(1) FOR LESS THAN 50 VOLTS – The breaker or fuse rating cannot exceed the Table 5 value by more than 150% (i.e., 1.5 times the table value) (See Example a).

(2) FOR 50 VOLTS OR MORE – The breaker or fuse should correspond exactly to the Table 5 value (See Example b). However, if a standard rating of breaker or fuse does not correspond to the Table 5 value, then the next larger size breaker or fuse may be used provided it does not exceed 150% (i.e., 1.5 times) the Table 5 value (See Example c).

EXAMPLE A – LESS THAN 50 VOLTS

For a No. 10 AWG, 90°C conductor in an engine room, Table 5 gives 45.1 amperes (55x.82 correction factor). 150% of this rating is 67.65 amperes (45.1x1.5). The MAXIMUM breaker current rating would be 67.65 amperes. (Practically, a 60 or 65 ampere device would be chosen).

EXAMPLE B – 50 VOLTS OR MORE

For a No. 6 AWG, 105°C conductor in an engine room, Table 5 gives 85 amperes (100x.85 correction factor). If a standard size breaker or fuse is available in this rating, it should be used.

EXAMPLE C – 50 VOLTS OR MORE

For a No. 6 AWG, 80°C conductor run with two other current-carrying-conductors, in circuits of 50 volts or more, in an engine room, Table 5 gives 54.6 amperes (100x.70 correction factor x .78 correction factor). As the next larger standard breaker or fuse rating is 60 amperes, this value may be used provided it does not exceed 150% of the table value. The 150% value would be 81.9 amperes (54.6x1.5) and, as 60 amperes is LESS than this, then a 60 ampere breaker or fuse is the maximum that may be used. Of course a lower rated circuit breaker may be used as could a larger conductor.

The boat manufacturer will have to determine the circuit loads in the boat in order to properly size conductors and the related overcurrent protection. If a conductor is supplying a single load, sizing the conductor and its overcurrent protection is simple. If, however, a single conductor is supplying multiple or cumulative loads such as a distribution panel, the boat manufacturer does not have to size the conductor to carry the summation of all the loads connected to the panel, but only a percentage of these loads due to loading factors. The regulation does not require that a conductor be sized to carry the full load of a distribution panel, but does require that proper overcurrent protection be provided for the size of conductor chosen.

Basically the boat manufacturer has a choice between the extremes of:

- providing a conductor that can carry the full load, or
- using a smaller conductor that is adequate because of load factors, but large enough to avoid nuisance tripping of its overcurrent protection.

Of course, whichever size conductor is used it must be protected with the proper size overcurrent protection. It must also be noted that 183.425(b) restricts the maximum load a conductor may carry to that specified in Table 5 except for intermittent higher currents as discussed on page 48.

REGULATORY EXCEPTIONS 183.455(e) –
This section does not apply to resistance conductors that control circuit amperage or voltage; pigtails of less than seven inches of exposed length; conductors in secondary circuits of ignition systems; and power supply conductors in cranking motor circuits.

DO YOU COMPLY

Is the current rating of each circuit breaker or fuse not in excess of:

- **150% of the amperage value in Table 5 for the conductor being protected in circuits of less than 50 volts,** ( )
- **the amperage value in Table 5 for the conductor being protected in circuits of 50 volts or more, except if the Table 5 value is not a standard size circuit breaker or fuse, is it the next larger size but not in excess of 150% of the Table 5 value.** ( )

IT'S THE LAW

183.455 OVERCURRENT PROTECTION: GENERAL

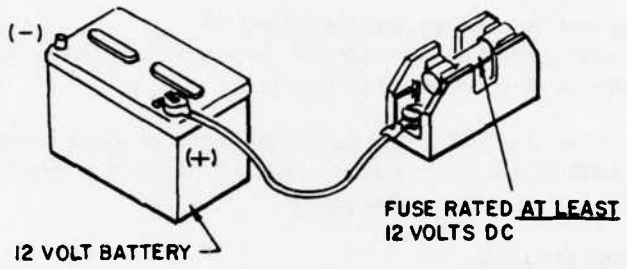
(d) The voltage rating of each circuit breaker or fuse must not be less than the nominal circuit voltage of the circuit it is protecting.

In addition to a current (ampere) rating, a circuit breaker or fuse also has a VOLTAGE RATING. In applying a circuit breaker or fuse the nominal VOLTAGE of the circuit must not be greater than the VOLTAGE RATING of the breaker or fuse. This is to ensure that the device will operate properly when an overcurrent (too many amperes) situation occurs (See Figure 37).

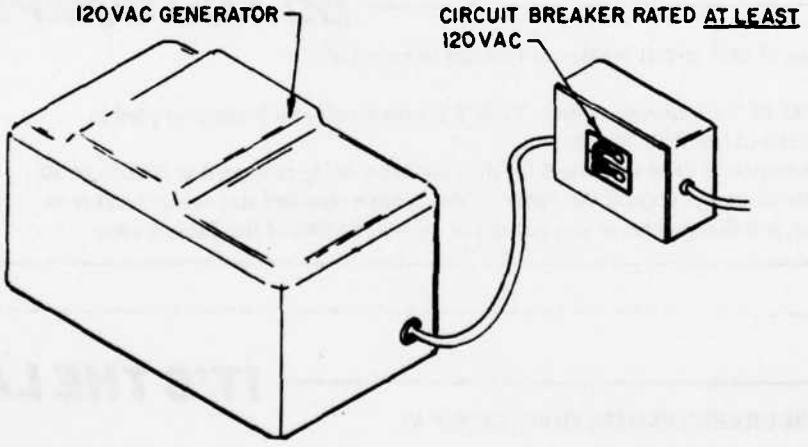
NOTE: "Nominal" circuit voltage means the "named" voltage – i.e. a 12 volt DC system may charge at about 13.8 volts, but the "nominal" circuit voltage is 12 volts DC.

REGULATORY EXCEPTIONS 183.455(e) –
This section does not apply to resistance conductors that control circuit amperage or voltage; pigtails of less than seven inches of exposed length; conductors in secondary circuits of ignition systems; and power supply conductors in cranking motor circuits.

FIGURE 37 – VOLTAGE RATING OF OVERCURRENT PROTECTION



NOMINAL 12 VOLT DC CIRCUIT
– a –



NOMINAL 120 VOLT AC CIRCUIT
– b –

DO YOU COMPLY

Is the voltage rating of each circuit breaker or fuse not less than the nominal circuit voltage of the circuit it is protecting? ( )

IT'S THE LAW

183.455 OVERCURRENT PROTECTION: GENERAL

(e) This section does not apply to resistance conductors that control circuit amperage or voltage; pigtails of less than seven inches of exposed length; conductors in secondary circuits of ignition systems; and power supply conductors in cranking motor circuits.

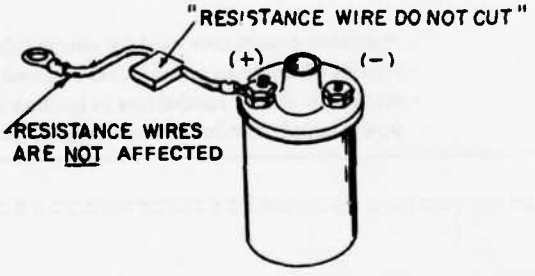
EFFECTIVE DATE: FEBRUARY 1, 1978

Conductors in some applications are not included in this requirement for overcurrent protection.

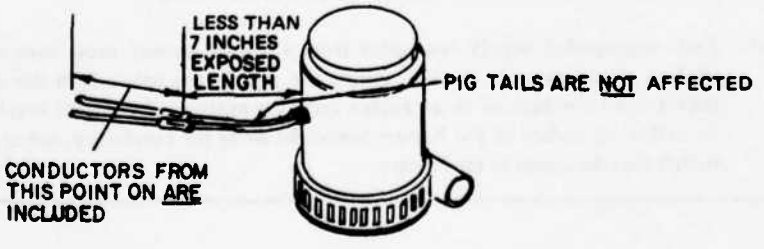
Overcurrent protection is not required for:

(1) resistance wire such as used in the low voltage side of ignition systems (See Figure 38a),
(2) pigtails or short leads (less than 7 inches) used to make a connection to the inside of a piece of equipment (See Figure 38b),
(3) wiring used in the ignition system secondary (See Figure 38c), and
(4) conductors ("battery cables") used to supply power to cranking motors (See Figure 38d).

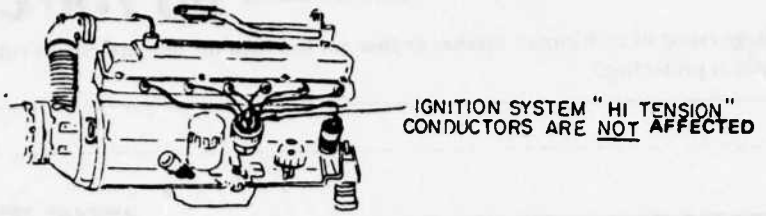
FIGURE 38 – OVERCURRENT PROTECTION EXCEPTIONS



RESISTANCE CONDUCTOR
– a –

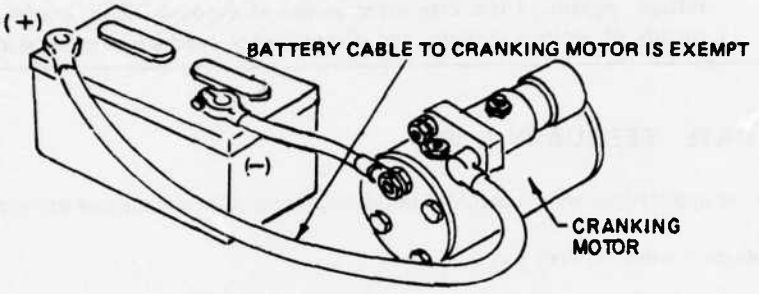


PIGTAILS OF LESS THAN 7 INCHES
– b –



IGNITION SYSTEM SECONDARIES

– c –



CRANKING MOTOR POWER SUPPLY CONDUCTORS

– d –

DO YOU COMPLY

NOTE PERMITTED EXCEPTIONS FOR:

- **resistance conductors used for control circuits**
- **pigtails of less than seven inches exposed length**
- **secondary circuit conductors in ignition systems**
- **power supply conductors in cranking motor circuits.**

IT'S THE LAW

183.460 OVERCURRENT PROTECTION: SPECIAL APPLICATIONS

(a) Each ungrounded supply conductor from a storage battery must have a manually reset, tripfree circuit breaker or fuse, unless the supply conductor is in the main power feed circuit from the battery to an engine cranking motor. The circuit breaker or fuse must be within 72 inches of the battery measured along the conductor, unless the circuit has a switch that disconnects the battery.

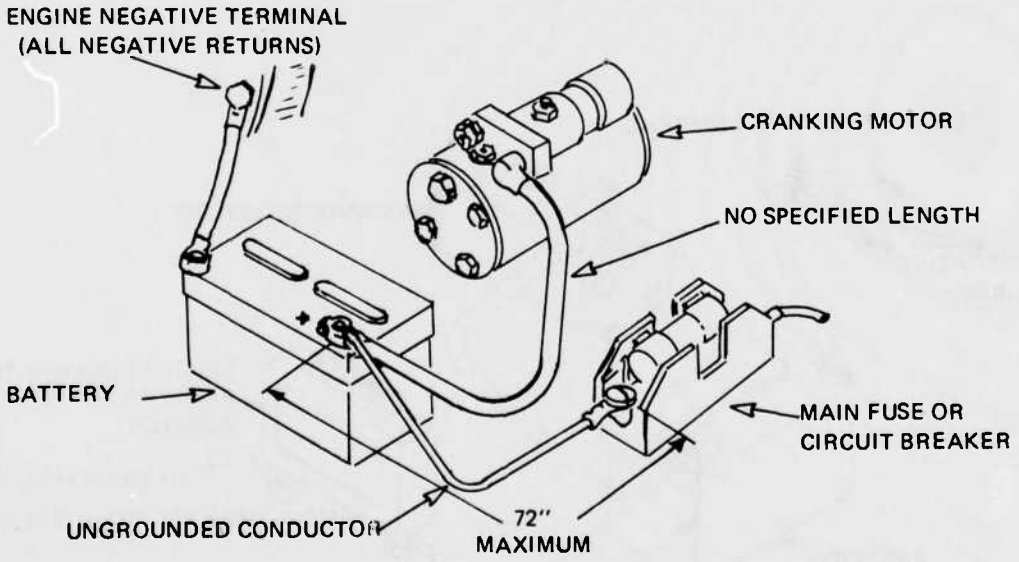
EFFECTIVE DATE: FEBRUARY 1, 1978

Ungrounded conductors connected to a storage battery, other than cranking motor conductors, must have overcurrent protection in accordance with 183.455(a). This section of the regulation provides an exception to 183.455(b) in that the overcurrent protection location for the above described battery cable may be a distance from the connection at the battery [183.455(b) requires the overcurrent protection to be at the power source]. The distance from the battery connection depends on whether or not the overcurrent protection device is equipped with a switch.

- Overcurrent protection without a switch must be located within 72 inches of the battery connection. (See Figure 39a)
- Overcurrent protection with a switch may be located anywhere along this battery cable. (See Figures 39b and c)

The only exception to the breaker or fuse requirement for supply conductors from batteries is for cranking motor power supply conductors as excepted in 183.455(e). Schematics of typical main supply circuits are shown in Figure 40.

FIGURE 39 -- LOCATION OF MAIN SUPPLY OVERCURRENT PROTECTION



OVERCURRENT PROTECTION WITHIN 72 INCHES OF BATTERY

– a –

AD-A049 638 COAST GUARD WASHINGTON D C OFFICE OF BOATING SAFETY F/G 13/10
ELECTRICAL SYSTEM COMPLIANCE GUIDELINE.(U)
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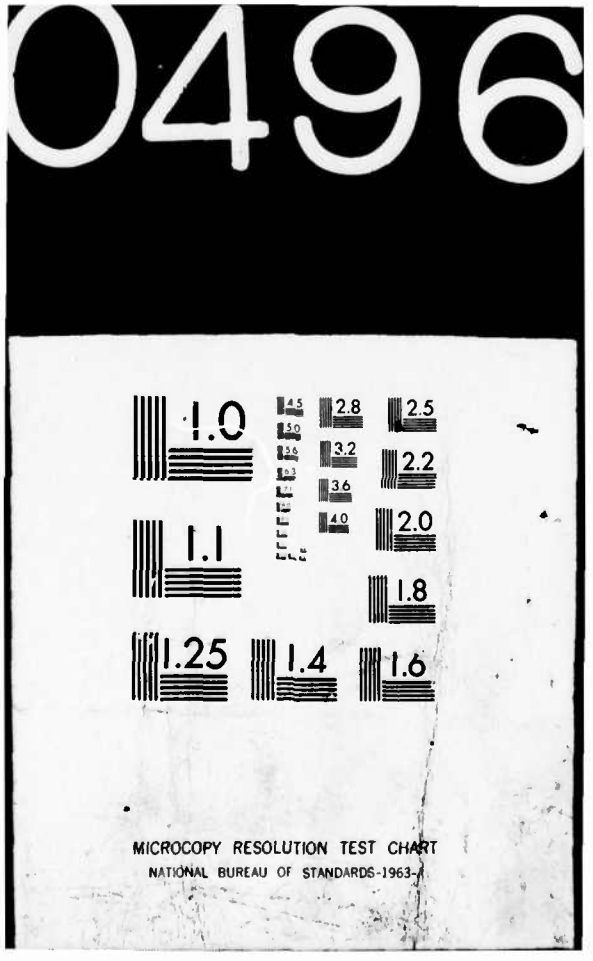
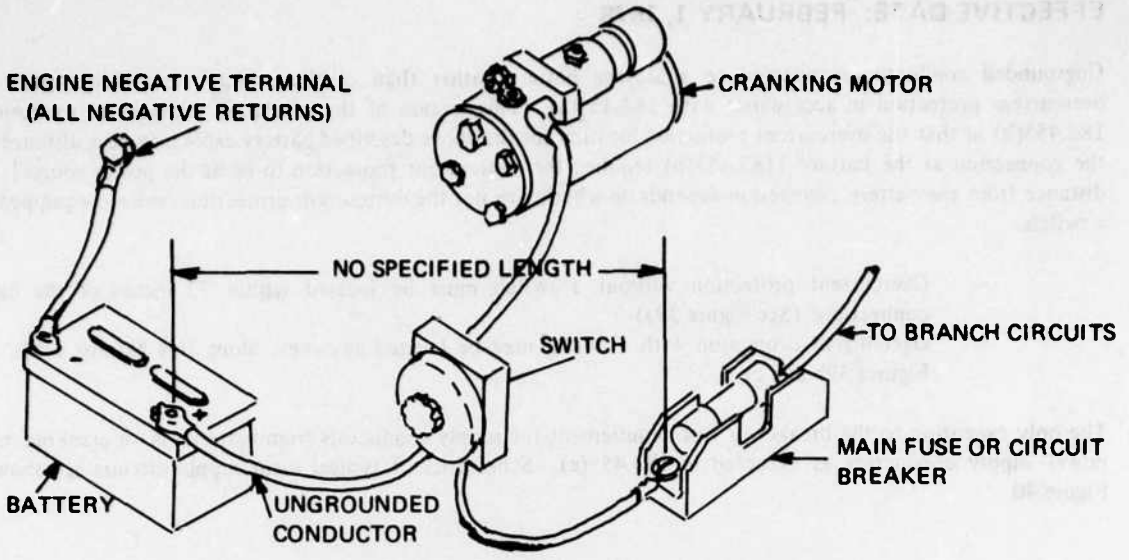
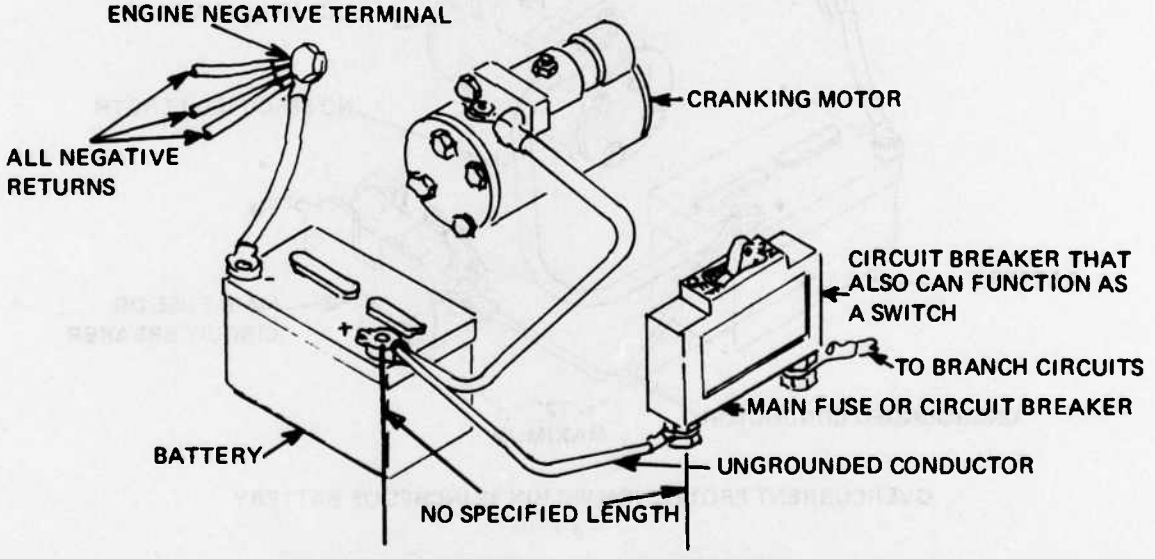

0496
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



OVERCURRENT PROTECTION AND SWITCH

– b –



OVERCURRENT PROTECTION WITH SWITCH

– c –

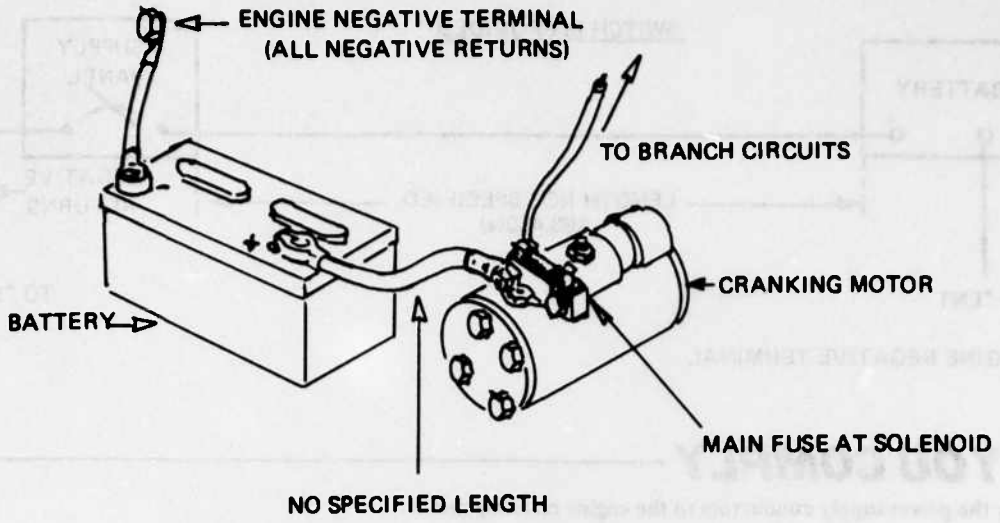
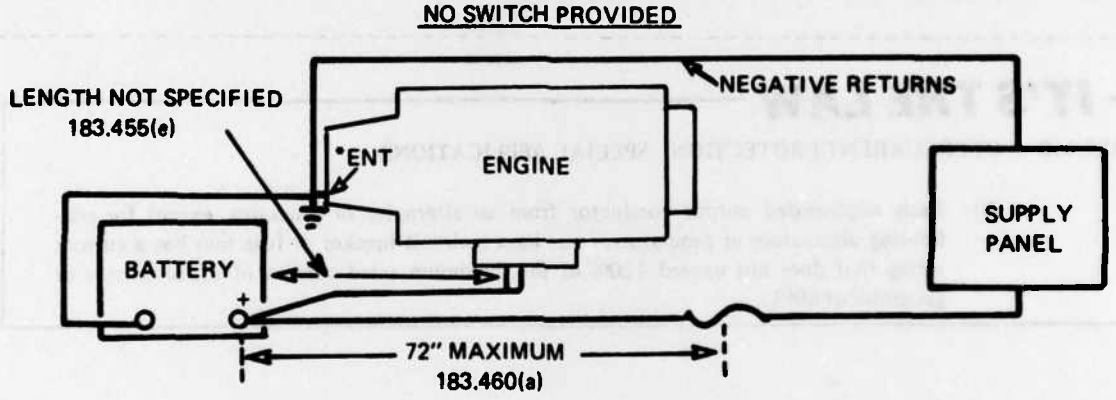
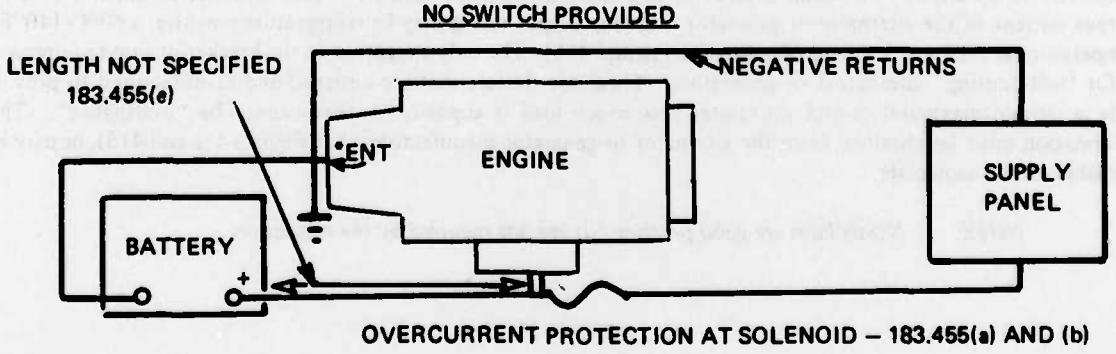
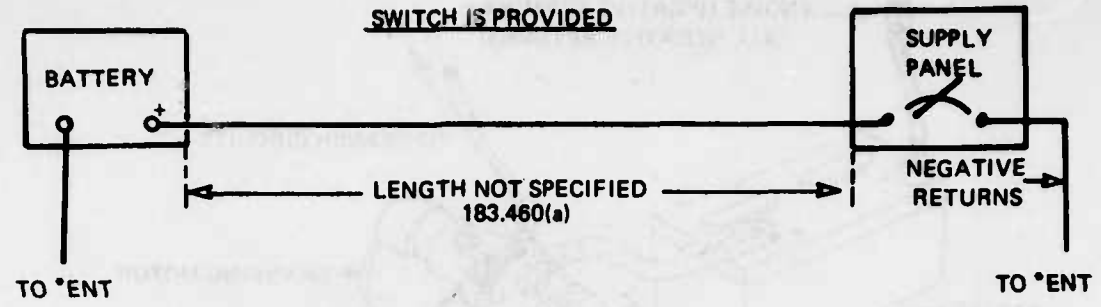


FIGURE 40 -- TYPICAL SUPPLY CIRCUITS







*ENT - ENGINE NEGATIVE TERMINAL

DO YOU COMPLY

Except for the power supply conductors to the engine cranking motor –

- is there a manually reset, tripfree circuit breaker or fuse in each ungrounded supply conductor from each storage battery? ( )
- is the circuit breaker or fuse within 72 inches of the battery measured along the conductor? or ( )
- is there a switch in the circuit to disconnect the battery? ( )

IT'S THE LAW

183.460 OVERCURRENT PROTECTION: SPECIAL APPLICATIONS

(b) Each ungrounded output conductor from an alternator or generator, except for self-limiting alternators or generators, must have a circuit breaker or fuse that has a current rating that does not exceed 120% of the maximum rated current of the alternator or generator at 60°C.

EFFECTIVE DATE: FEBRUARY 1, 1978

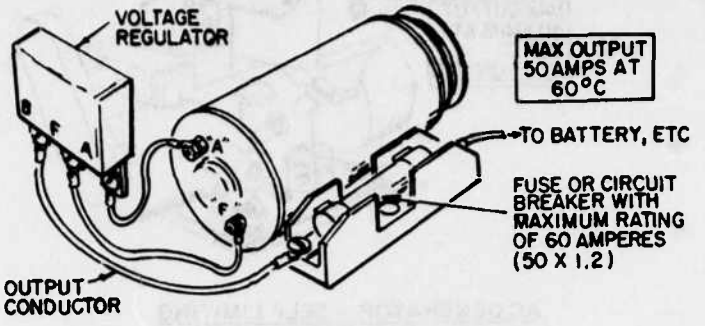
The output of alternators or generators (AC or DC) must have overcurrent protection (as described in 183.455). This must be by means of a circuit breaker or fuse rated at no more than 120% (1.2 times) of the maximum rated output current of the alternator or generator. As this output rating may be temperature sensitive, a 60°C(140°F) temperature is used as a standard (See Figures 41a and 41b). The only exception to the breaker or fuse requirement is for "self-limiting" alternators or generators. These are devices that are designed and manufactured to provide only a certain maximum output no matter how much load is applied, i.e. they cannot be "overloaded". This information must be obtained from the alternator or generator manufacturer (See Figures 41c and 41d), or may be available on the nameplate.

NOTE: Nameplates are good practice but are not required by the regulation.

The "self-limiting" concept can also be applied to certain battery chargers, magneto grounding circuits, and other similar electrical components that provide electrical output for specific functions. This electrical output is limited by the construction of the electrical components no matter what the load, and when its output circuit is grounded the voltage drops to zero.

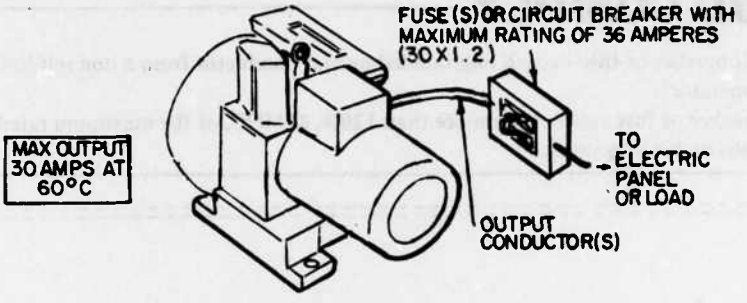
The overcurrent protection requirements of section 183.455 apply to ungrounded conductors. For the purpose of these requirements the conductors used with sender units such as fuel gages, oil temperature switches, thermostats, etc. are considered to be grounded conductors and do not require overcurrent protection. The supply conductors to the gage or other measuring systems are protected by overcurrent protection and this protection indirectly protects the grounded conductors discussed above.

FIGURE 41 – ALTERNATORS AND GENERATORS



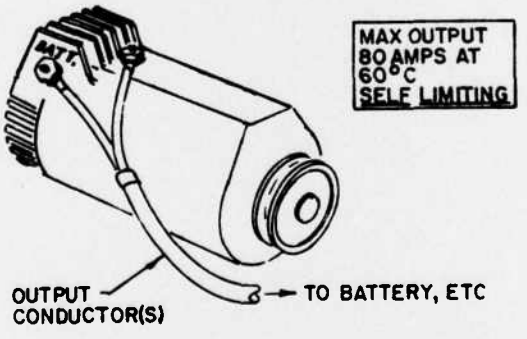
DC GENERATOR – NOT SELF LIMITING

– a –



AC GENERATOR – NOT SELF LIMITING

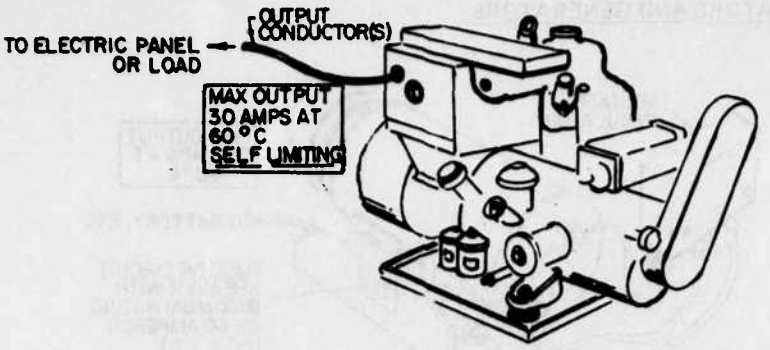
– b –



DC ALTERNATOR – SELF LIMITING

NO PROTECTION REQUIRED

– c –



AC GENERATOR – SELF LIMITING
NO PROTECTION REQUIRED
– d –

DO YOU COMPLY

Is there a circuit breaker or fuse in each ungrounded output conductor from a non self-limiting alternator or generator?	**( )**
Is the circuit breaker or fuse rated at not more than 120%, at 60°C, of the maximum rated current of the alternator or generator?	**( )**

TYPICAL WIRING DIAGRAMS

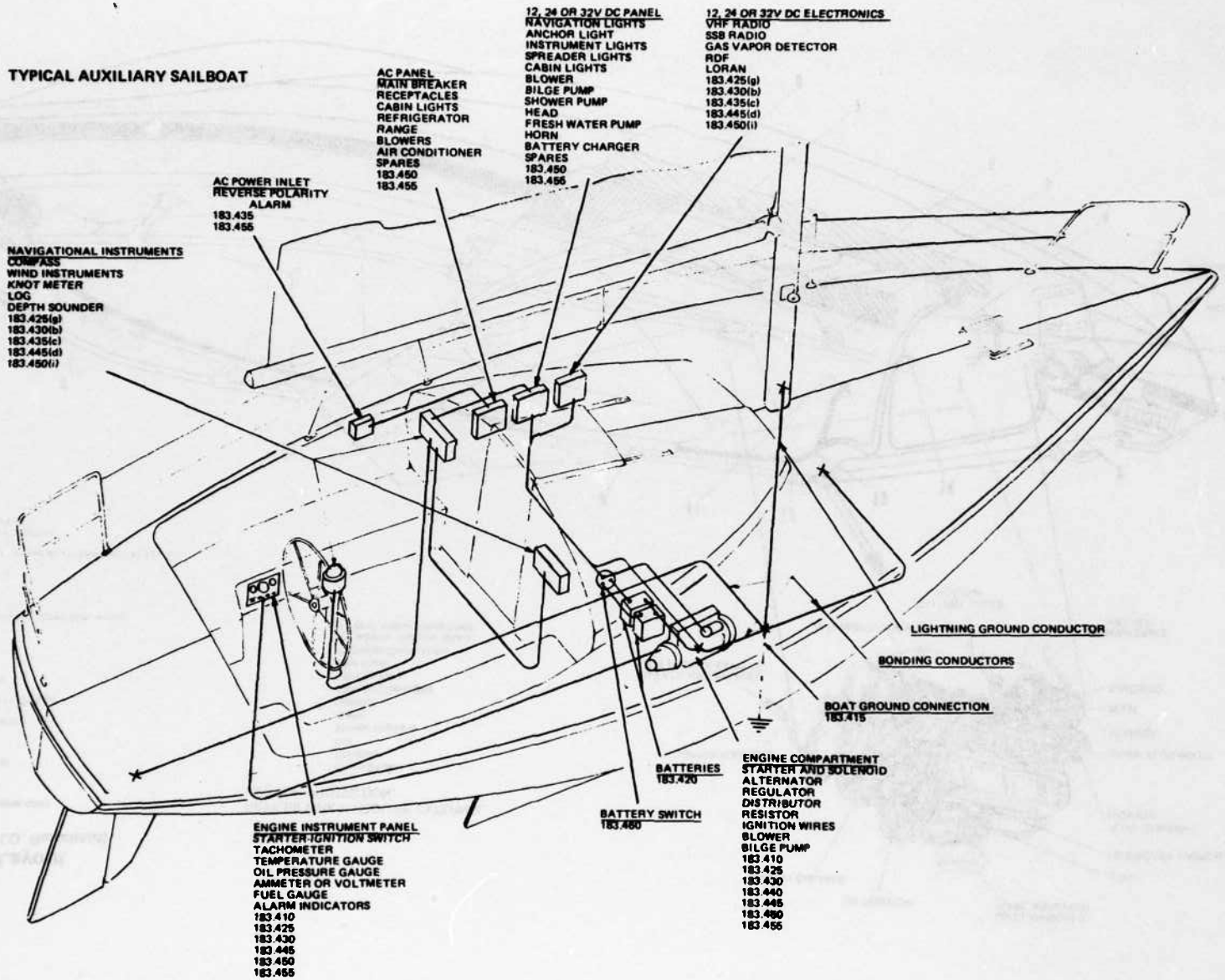
AUXILIARY SAILBOAT

INBOARD AND I/O RUNABOUT

INSTRUMENT WIRING

HARNESS

CRUISER – WIRING – LESS THAN 50 VOLTS
WIRING – 50 VOLTS OR MORE

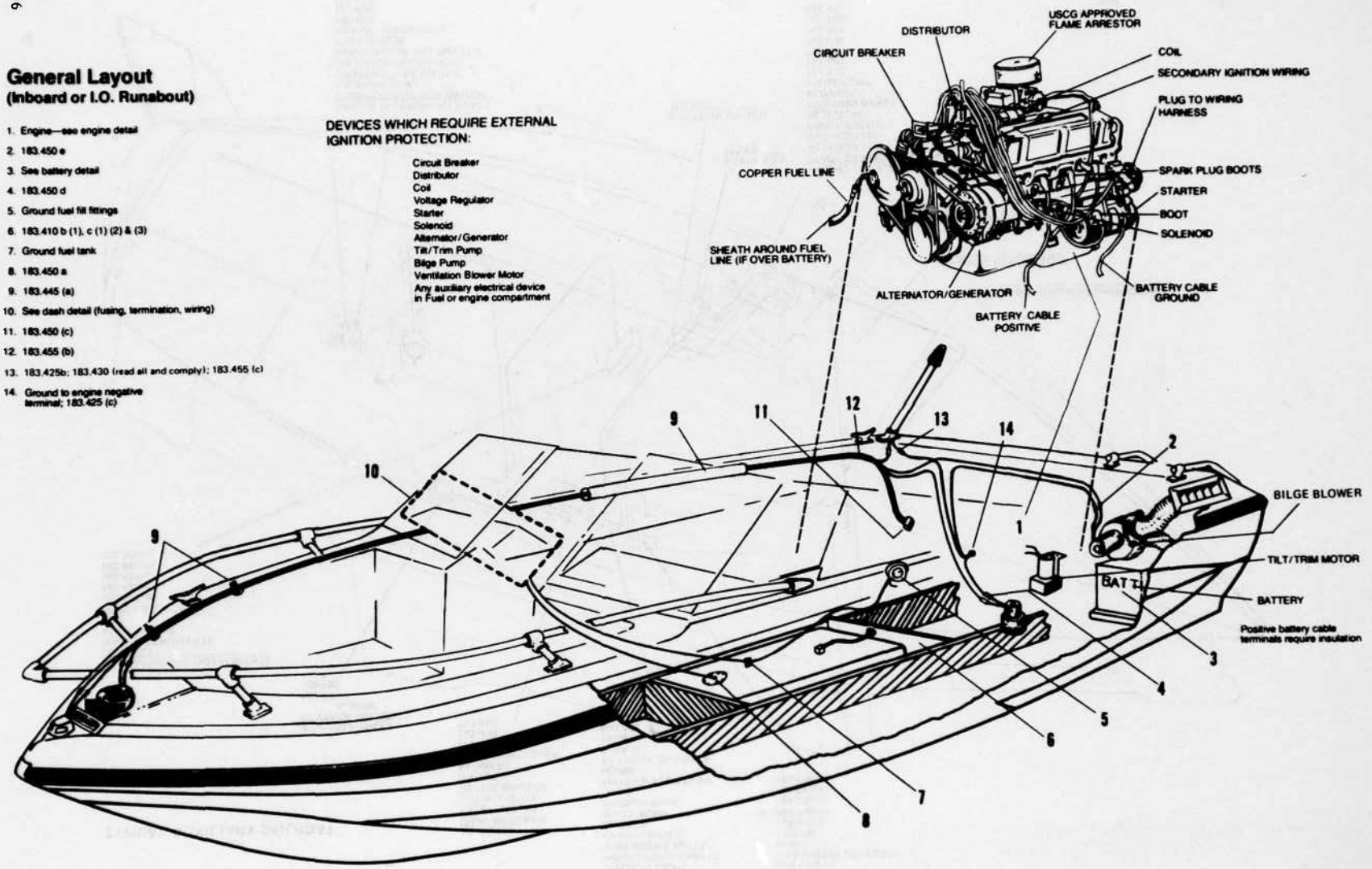


General Layout
(Inboard or I.O. Runabout)

1. Engine—see engine detail
2. 183.450 e
3. See battery detail
4. 183.450 d
5. Ground fuel fill fittings
6. 183.410 b (1), c (1) (2) & (3)
7. Ground fuel tank
8. 183.450 a
9. 183.445 (a)
10. See dash detail (fusing, termination, wiring)
11. 183.450 (c)
12. 183.455 (b)
13. 183.425b; 183.430 (read all and comply); 183.455 (c)
14. Ground to engine negative terminal; 183.425 (c)

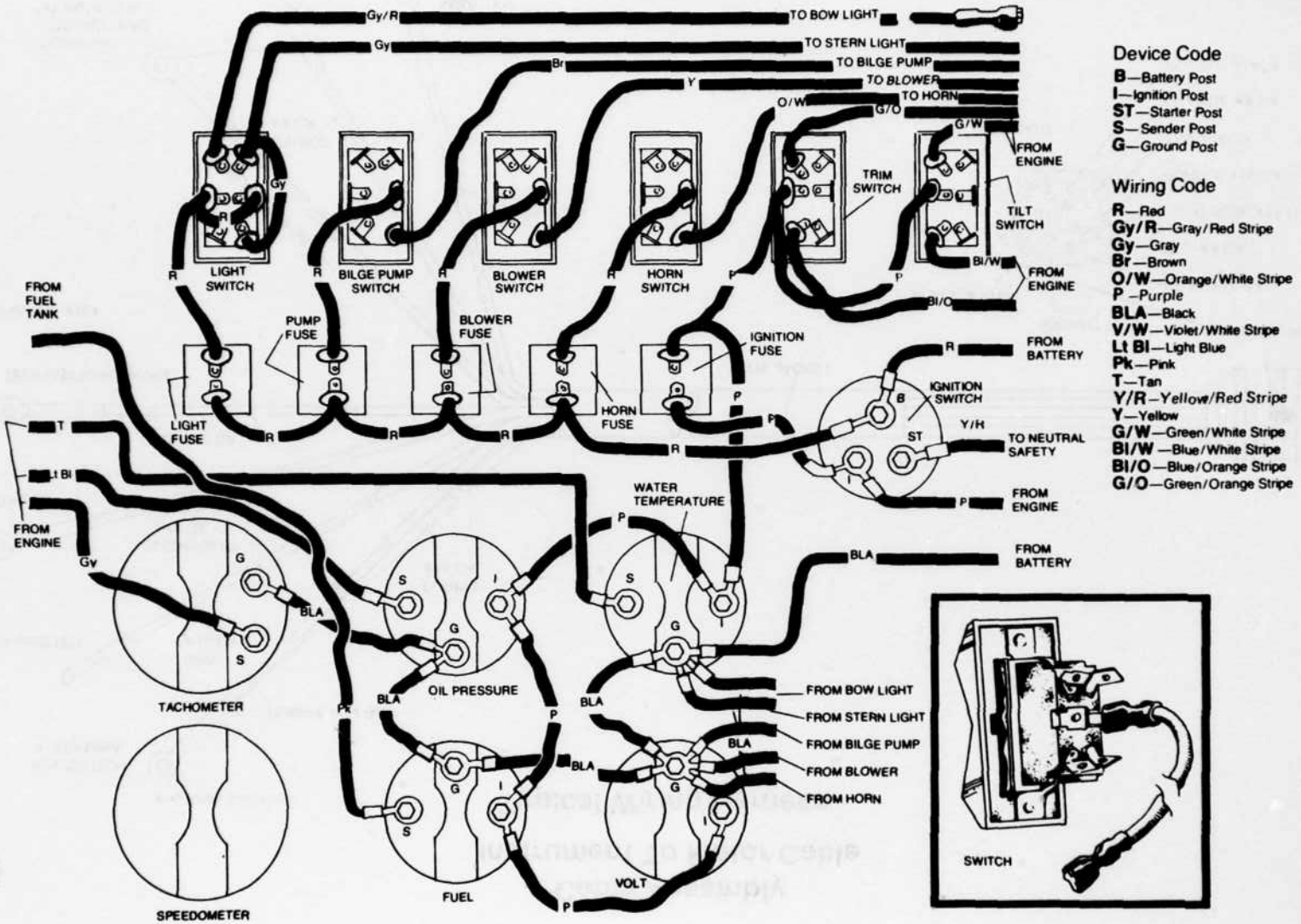
DEVICES WHICH REQUIRE EXTERNAL IGNITION PROTECTION:

Circuit Breaker
Distributor
Coil
Voltage Regulator
Starter
Solenoid
Alternator/Generator
Tilt/Trim Pump
Bilge Pump
Ventilation Blower Motor
Any auxiliary electrical device in Fuel or engine compartment



Typical Instrument Wiring Assembly

Rear View of Panel



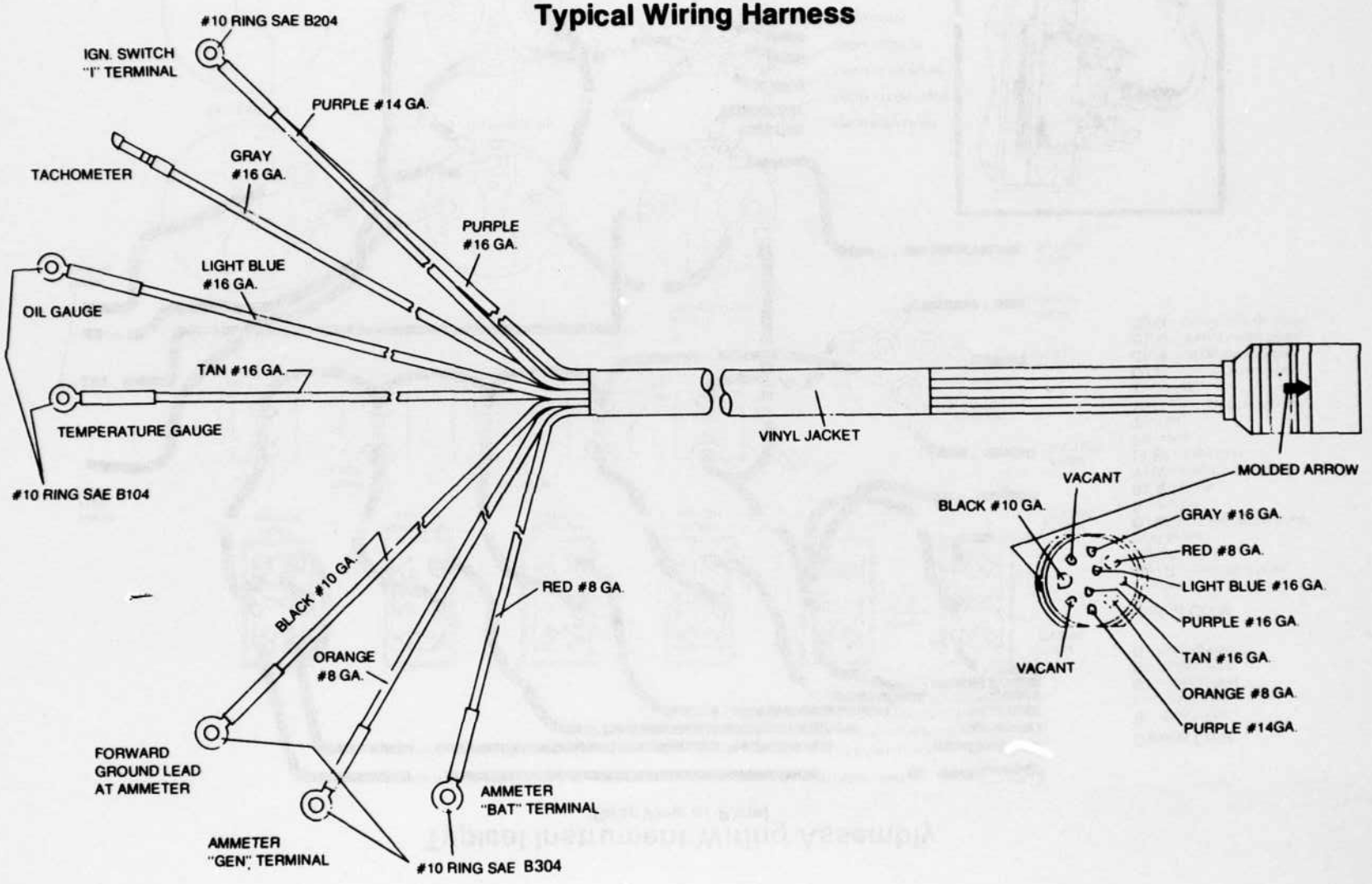
Device Code

B—Battery Post
I—Ignition Post
ST—Starter Post
S—Sender Post
G—Ground Post

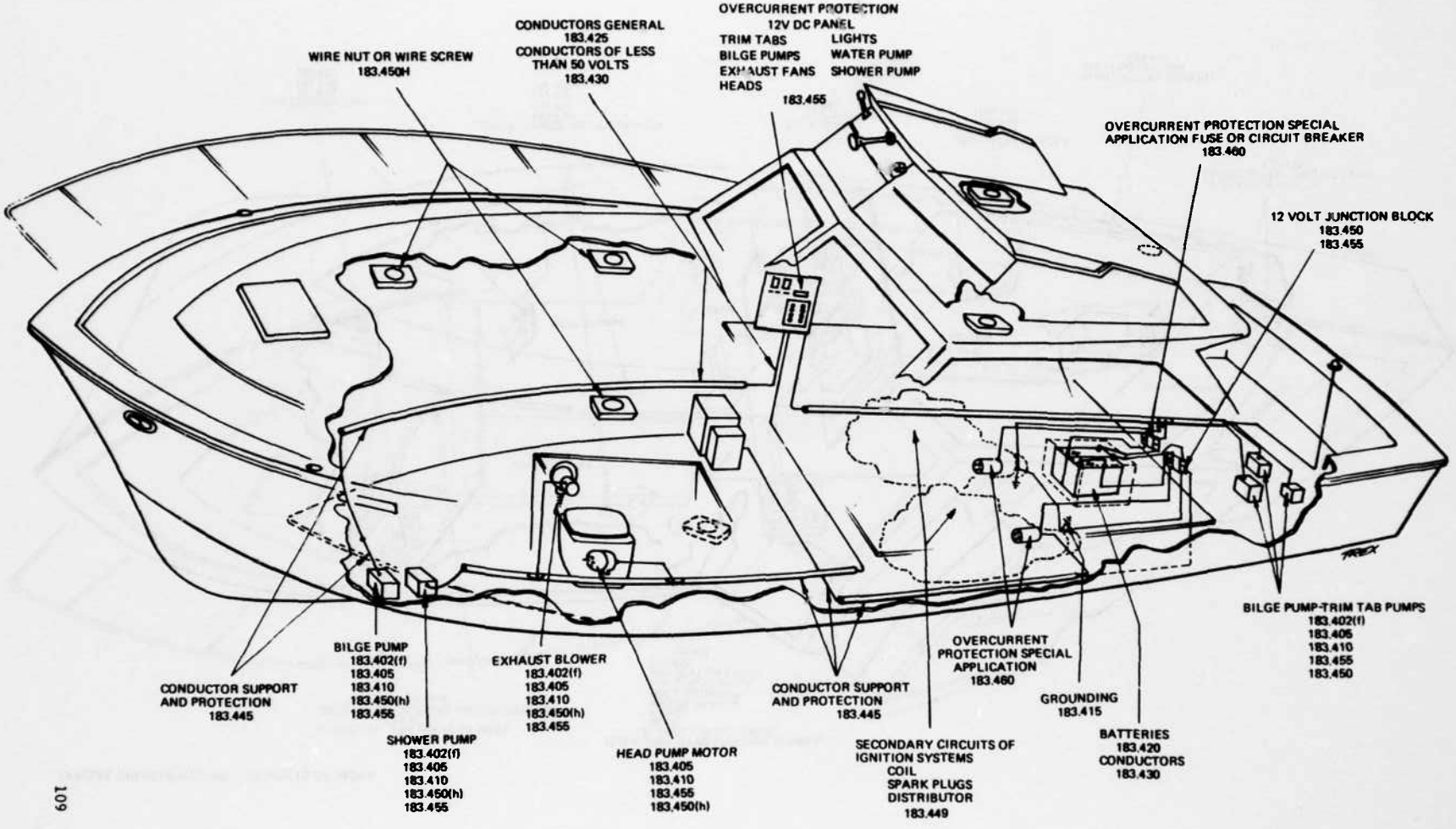
Wiring Code

R—Red
Gy/R—Gray/Red Stripe
Gy—Gray
Br—Brown
O/W—Orange/White Stripe
P—Purple
BLA—Black
V/W—Violet/White Stripe
Lt Bl—Light Blue
Pk—Pink
T—Tan
Y/R—Yellow/Red Stripe
Y—Yellow
G/W—Green/White Stripe
Bl/W—Blue/White Stripe
Bl/O—Blue/Orange Stripe
G/O—Green/Orange Stripe

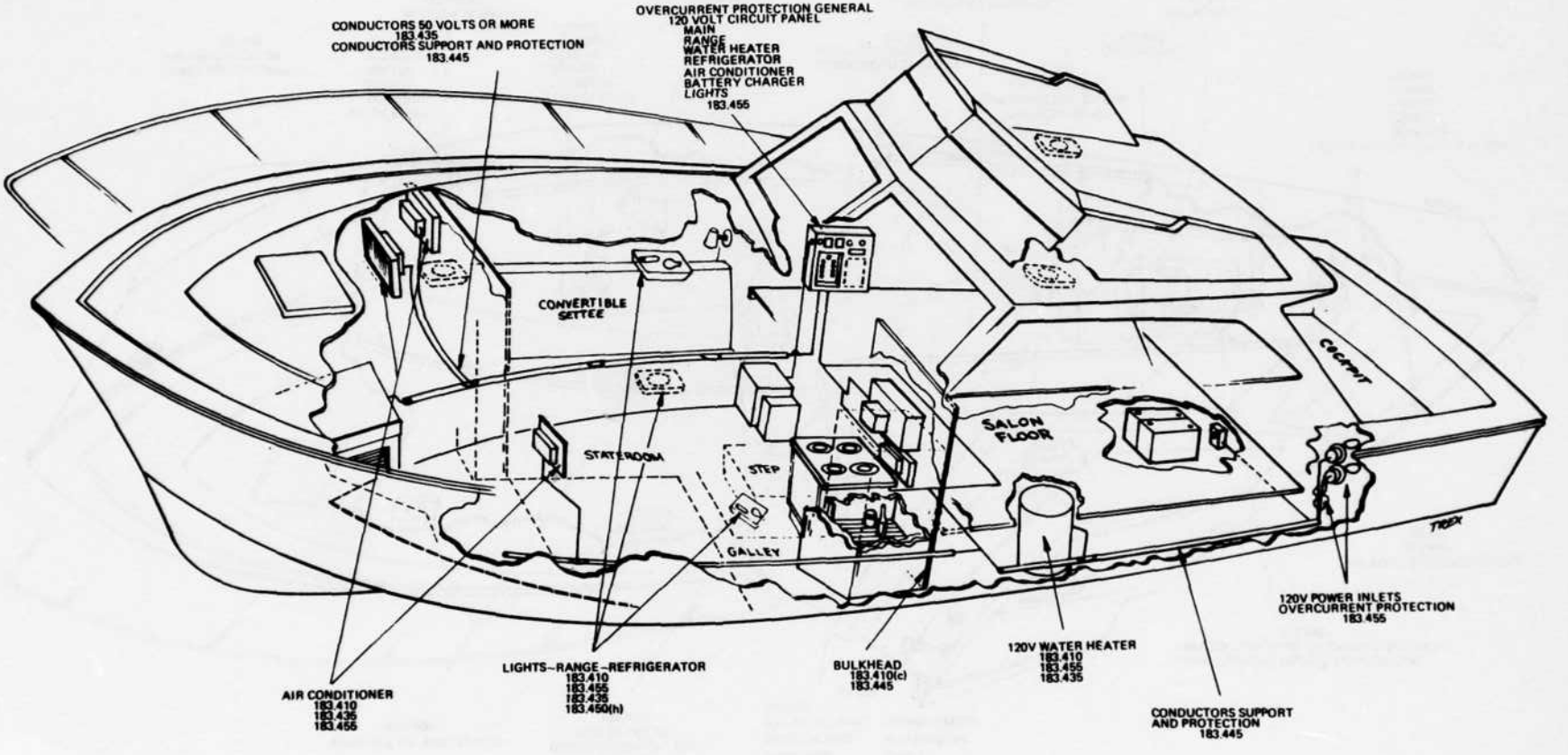
Cable Assembly
Instrument To Motor Cable
Typical Wiring Harness



TYPICAL CRUISER WIRING - LESS THAN 50 VOLTS



TYPICAL CRUISER WIRING - 50 VOLTS OR MORE



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